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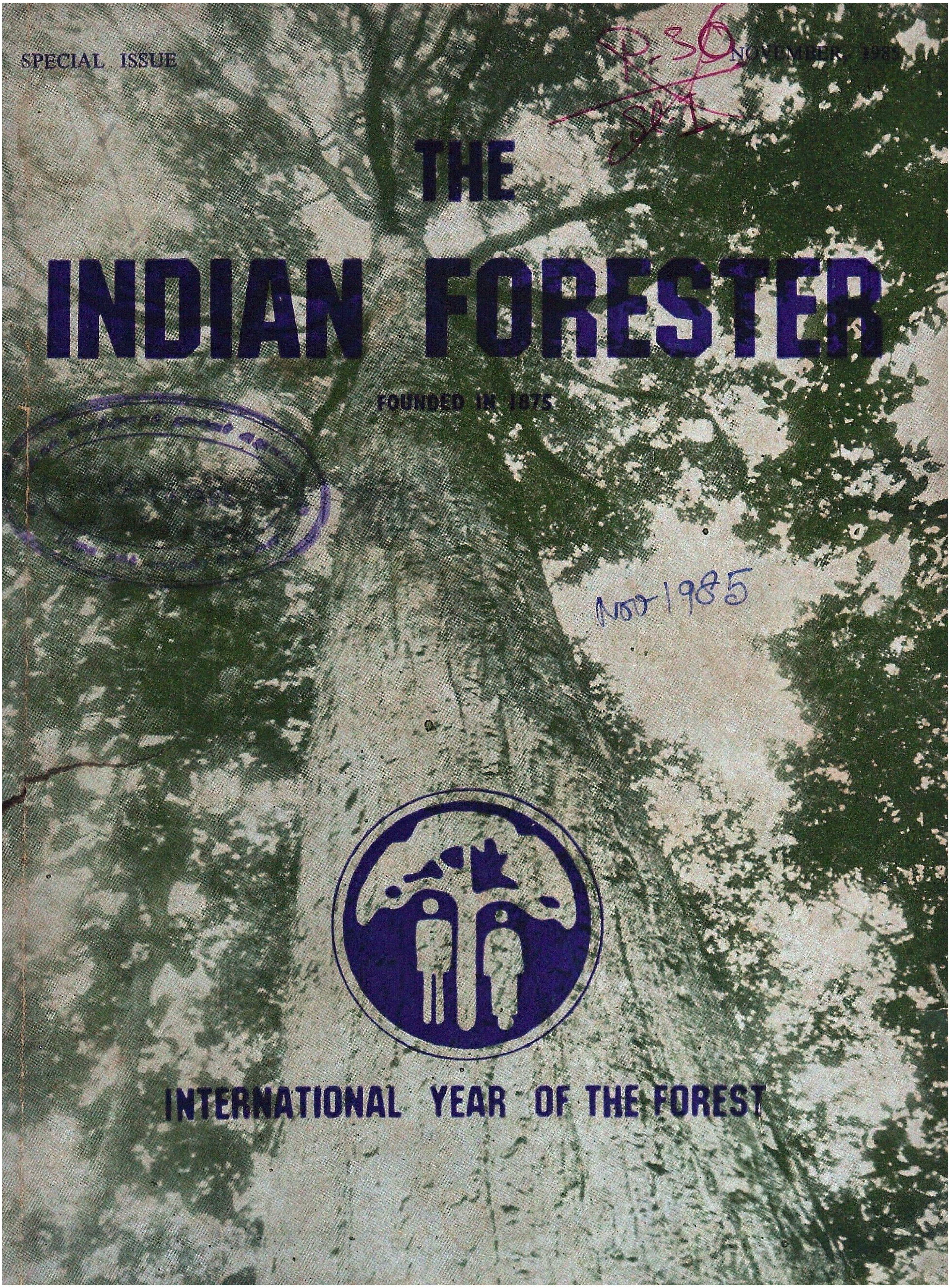

THE INDIAN FORESTER

FOUNDED IN 1875

Nov 1985

INTERNATIONAL YEAR OF THE FOREST

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INDIAN FORESTER

(A Monthly Journal of Forestry and Forestry Research)

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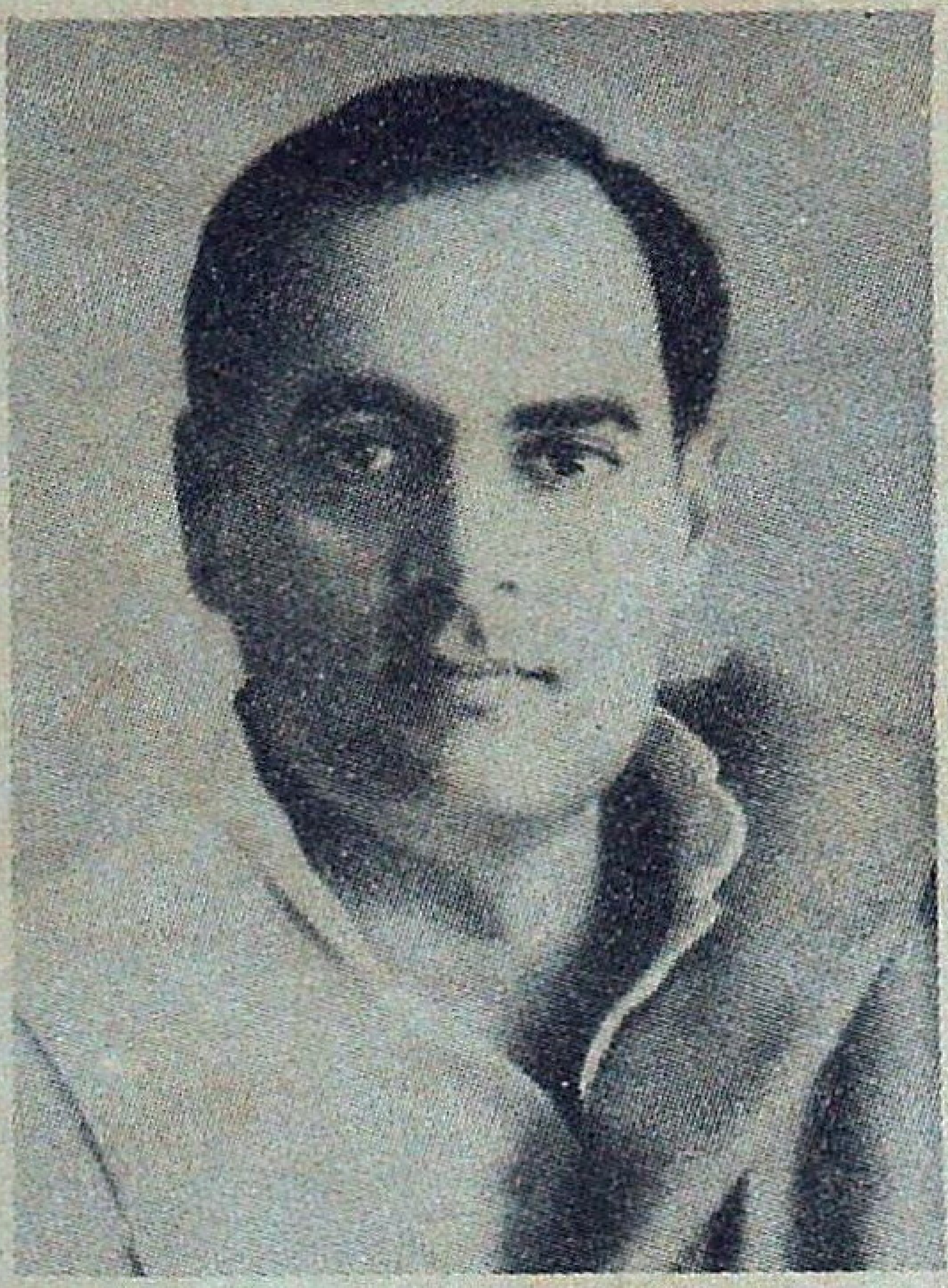

सत्यमेव जयते

SMT. RAJESHWARI TANDON
SOCIAL SECRETARY TO PM
PRIME MINISTER'S OFFICE
NEW DELHI-110 011

September 16, 1985

MESSAGE FROM PRIME MINISTER TO HONY. EDITOR

The Prime Minister Shri Rajiv Gandhi is pleased to know that the Forest and Forestry Research offices will be publishing a commemoration issue on forests. He sends his good wishes to the staff and readers of the *Indian Forester*, November 1985, which highlights the many socio-economic aspects of forestry in our country.

सत्यमेव जयते

MINISTER OF STATE
ENVIRONMENT & FOREST
INDIA
NEW DELHI-110011

January 6, 1985.

MESSAGE

1985 has been declared as the International Year of the Forests by the Food and Agriculture Organisation of the United Nations in order to focus international attention on the conservation of forestry resources and to increase recognition of their role in rural development.

The Government of India fully supports the objectives of the International Year of Forests. Conservation of forests resources has become our main concern. In addition, a number of steps to step up productivity of forests and to organise a people's movement to undertake a massive programme of afforestation have been initiated.

The technological break-through needed to achieve these objectives demand total dedication of all those involved in the profession. I hope this message will be carried to them through your journal.

-Z.R. ANSARI

सत्यमेव जयते

SPECIAL SECRETARY,
GOVERNMENT OF INDIA
DEPARTMENT OF FORESTS & WILDLIFE
KRISHI BHAWAN
NEW DELHI- 110001

11th Sept.1985.

MESSAGE

The Council of the United Nations,FAO at its 86th Session, in November 1984, passed a resolution calling attention to the growing threat tothe world's diminishing forest resources and declaring 1985, as the FAO 'International Year of the Forests'. In pursuance, the Council urged that all possible measures, be taken by every country to heighten public awareness of the importance of world's forests to the future of mankind.

The Council appealed to the FAO member nations to accord special recognition to forests during 1985, to regard their conservation as a matter of national and global concern and to awaken public consciousness of the role and importance of forests towards quality of life, environmental stability and socio-economic progress.

The dominant theme of the International Year is "Forestry and Fuel Security" with the following support themes :

(i)	"Forestry & People"	involving communities in enhancing benefit from forest resource.
(ii)	"Conserving the Forests"	dealing with problems of unplanned agricultural expansion, acid rain,forest fires, desertification and industrial pollution.

(iii) "The Fuelwood Crisis" - dealing with acute dearth of wood for energy which is tending to threaten hundreds of millions of people over the next several decades.

(iv) "Appropriate Industries" - including the whole gamut, from local household to large-scale forest-based industries.

We are planning to celebrate in our country, in a befitting manner, the International Year of the Forests. This year significantly coincides with the International Year of Youth. Our country, nay the whole world looks forward to our energetic youth, of promise and vigour, to play an effective role in enriching and developing our forests to their fullest potential. This Year is also memorable as the IX World Forestry Congress was held at Mexico City, in July, which focussed attention to the need to redefine forest policies, in the light of new insights and development in forestry and the needs and aspirations of the people. It heightened awareness of the challenge of the future, the fresh tasks to be accomplished and the new approach to them.

This Year also marks the setting up of the National Wastelands Development Board in the country, in pursuance of the Prime Minister's broadcast to the nation, to undertake massive afforestation through people's participation, to bridge the staggering gap between demand for and availability of fuelwood and fodder and to speedily restore ecologically, our degraded land.

Afforestation gained momentum in the country during the VI Five Year Plan. The VII Five Year Plan aims at intensifying this effort substantially, inclusive of wasteland development through people's participation.

Another notable feature of this Year is the recognition accorded to forestry by the Government of India, in elevating it, to the status of a fullfledged Department, with the Prime Minister himself at its helm, under whose dynamic leadership, forestry holds promise of making great strides for the welfare of mankind.

Our country is facing great odds, in protecting its forests,(which are only 2% of the forests of globe) against relentless pressure, from nearly 14% of the human and 15% of the cattle population of the world.

Let us pledge ourselves during this Year to overcome this challenge, with faith and determination and rededicate ourselves to make our country prosperous through our forest resources, for in whatever forests fulfil,the touchstone and measure of their value, is human weal and satisfaction.

-L.H.A. Rego

VOLUME III **NUMBER 11**

THE INDIAN FORESTER

NOVEMBER, 1985

EDITORIAL

The truth that forests play significant role in conserving the life and serve the mankind in many ways need no elaboration. The forest resources of the world are diminishing fast, whereas the needs are increasing day by day by many folds. The situation is hard pressing and needs immediate solution. The peoples participation is very essential in production of forestry goods and services. The Prime Minister Shri Rajiv Gandhi has aptly said "Forestry has to be made a real peoples movement". The science and technology have a crucial role to play in improving the productivity of degraded and difficult sites, conservation of soil and water and genetic diversity. Massive programmes of afforestation initiated by the Government need peoples support. Food and Agricultural Organisation has timely declared 1985 as "International Year of the Forests" to attract the attention of the people to the problem of diminishing forest resources in the world and to take remedial steps by protecting the forests and growing trees on a massive scale for the sake of quality of life, environmental stability and socio-economic progress. The timely awareness of the people of the world in whatever capacity they are will protect the future generations from the calamity. If the forests are protected and more trees grown the problems of fuel, fodder, timber and pollution will be solved and life on the planet sustained.

The issue of *Indian Forester* is being brought out to commemorate the year of 1985 as "International Year of the Forests". Attempt has been made to incorporate the article of general importance in forestry sciences and highlight current problems in this special issue. It is hoped that this issue will convey the message to all and bring awareness for right action in near future to make the nation more green and prosperous.

G.P. Maithani
Hony. Editor

THE ROLE OF FOREST AND WILDLIFE EDUCATION IN ENVIRONMENTAL CONSERVATION

L. H. A. REGO
Special Secretary and Inspector General of Forests
Department of Forests and Wildlife, New Delhi

The role of Forests in Environmental conservation

The role of forests in environmental conservation, is well recognised. Of all the ecosystems the fores ecosystem is the largest, most complex and most self-penetrating. From the point of view of flora and fauna, it has the most diverse gene-pool. It is in the forests, that the natural regulatory processes excel, producing the most stable of all ecosystems. The forests therefore, play a vital role in environmental conservation.

Our hoary conservation tradition

The principle of conservation has all along,been an integral part of the Indian ethos. This is borne out by our ancient scriptures and historical records. The best in Indian culture was born in the forests. The Aryan civilization was cradled in our forests and our *rishis,* who evolved the Hindu philosophy, lived in complete harmony with nature and meditated in the peace and serenity of the woods, to give us the supernal values and ideals through our ancient scriptures, the *Vedas* and the *Upanishads*. Their*ashrams*, were an epitome of man living in close communion with nature, with the trees, birds and animals. *Ahinsa paramodharma,* is a basic tenet of our religion and philosophy. Lord Buddha, describes the forests as "a peculiar organism of unlimited kindness and benevolence, that makes no demands for its sustenance but extends protection to all beings, offering shade even to all the man with the axe, who destroys it." No wonder then, that Gautam, sought the shelter of the *bodhi*tree, to become the *Buddha*, the Light of Asia. The world's first recorded conservation measures, were enacted in India, during the third century B.C., in the days of Emperor Asho la, whose benevolence extended to all living beings. His edicts on stone, on nature conservation,survive even today. There is now an acceptance of the idea, of the oneness of life and of our earth. The survival of man is dependent on the survival of animal and plant life. The hoary tradition of our country in conservation, continues even today and we have the inspring example of the*bishnoi* community in Rajasthan, Haryana and Uttar Pradesh, dedicated to protecting our trees and wild animals. The recent *chipko* movement,which emanated from Chamoli, in the inner Himalayas, is another striking reflection of this concern, in the minds of the people.

Forest as an important facet of environment

The importance of forests be over-emphasised. In whatever the forests fulfil, the touchstone and measure of their value, is human weal and satisfaction. The late Shri K.M. Munshi, defined its role beautifully when he said: "There is a balance on earth between air, water, soil and plant. Trees have a great place in the economy of nature. They hold up the mountains, cushion the rain and storms. They discipline the rivers and control the floods. They maintain the springs, they break the winds, they foster the birds. They keep the air cool, and clean. They are the guardians of the perennial springs of water They are the natural defenders of dust storms. They prevent erosion by wind and water and they preserve the fertility of the soil".

The future of mankind, is inextricably linked with forests, both as a national resource and as the strength behind a healthy environment. The ecological perspective, has to embrace diverse aspects, ranging from sustenance linkags of the rural communities and the demands of a developing economy, to the dictates of scientific management, assuring sustainable utilisation of the national resource.

Nature has lavishly endowed our country, with a rich biotic heritage, with nearly 5% of all known plant and animal species found on the earth. Our flora and fauna, include about 13,000 species of flowering plants, 30,000 species of insects, 10,500 species of molluscs and other invertebrates, 2000 species of fish, 140 species of amphibians, 420 species of reptiles, 1200 species of birds and 340 species of mammals, besides a vast variety of oceanic fauna. No other country in the world, area for area, excels India, in the variety of its biological reserves.

The forest crisis

Despite our rich and hoary tradition in nature conservation and the need to preserve our forests inviolate, there have been many factors which have proved inimical. The grim reality is, India with as high as 15% of the human and 14% of the cattle population of the world, has barely 2% of forests of the globe. The enormous and relentless pressure on our diminishing forests, is therefore at once manifest. Nevertheless, of late, there has been a general awakening to protect our forests, which are virtually under a sage. This awakening however, has to be translated into reality. " One touch of nature, makes the whole world kin,"Says Shakespear.

It would be pertinent to recall the following apt observation by UNESCO on the "environment crisis".

> "Imperfect understanding of the natural mechanisms which make possible the maintenance of life on earth; disregard of the unintentional effects of technology, in particular, the various forms of pollution; poor management of the soil, forests and water; unbridled consumption of fossil fuels; uncontrolled urbanisation; the relegation of the population to a marginal possition; and the crushing of traditional cultures these are the obvious and most frequent disadvantages of the change that is taking place in the relations between man and his environment".

In this context, we need to ponder, as to how we could achieve material progress, without impairing the environment. Our late Prime Minister Smt. Indira Gandhi, in her stirring address in 1972, at the United Nations Conference, at Stockholm, on Human Environment, advocated "Development without Destruction", as the cardinal principal of planning. Sensitive to the harm that thoughtless and unimaginative economic development can cause to the environment, through reckless destruction of forests and the resulting problems of soil erosion and flood, she was perceptive to the supreme importance of conservation in planning. Like a seer, the drew upon the fountain of wisdom and insight, from our ancient culture, to rivet attention to nature, being imperilled by despoilation.

Paramount needs which the Forests are required to fulfil

The following are the paramount needs of the country, which the forests are required to fulfil :

Maintenance of environmental stability, through preserving and where necessary, restoring the ecological balance, that has been adversely disturbed, by an insufficient appreciation of the role of forests and consequently their rapid depletion;

Conservation of what remains of the natural heritage of the country through preserving the existing natural forests, along with their vast variety of flora and fauna, which represent the tremendous biological diversity and genetic resources of the country;

Checking denudation and soil erosion in the catchment areas of rivers, in the interest of soil and water conservation, prevention of floods, as well as drought and control of premature siltation of reservoirs built at substantial cost;

Checking erosion along treeless

banks of rivers, in the hot and cold deserts of Thar and Ladakh and their environ; on large stretches of wastelands in the hilly and drier parts of the country; on areas denuded of vegetation by "shifting cultivation" and on barren sea-shores;

Safeguarding and sustaining the welfare of tribal communities, which almost subsist on the use of various forest resources; generating productive employment for the large number of unemployed and under-employed people, in the rural sector, in programmes of afforestation of degraded lands, whether Government or privately owned, and the need for generating forest-based employment for rural artisans;

Generating productive employment for the large number of unemployed and under-employed people, in the rural sector, in programmes of afforestation of degraded lands, whether Government of privately owned, and the need for generating forest-based employment for rural artisans;

Meeting the requirement of fuelwood, fodder, minor forest produce and small timber, of the rural and tribal population, primarily, through afforestation of all denuded and degraded lands, regardless of their classification;

Eliminating the pressure of industry, on natural forests, through the afforestation of all denuded and degraded lands;

Encouraging more efficient use of forest resources by all sectors of society;

Providing amenities for recreation and conservation education, in urban and rural environment; and

Creating a people's movement, for achieving these objectives.

Objectives of environmental education

Environmental education in its wide compass, is primarily governed by the following objectives, in respect of both individuals as well as the community.

(i) Bringing about an awareness of and sensitivity to the environment as a whole and its allied problems.

(ii) Promoting understanding of the total environment, its related problems and the role and responsibility of the people in a critical situation.

(iii) Instilling of social values, and genuine feeling of concern, for environment and motivation towards active involvement towards its protection and improvement.

(iv) Imparting of requisite skills, to help solve environmental problems.

(v) Evaluation of Environmental measures and educational programmes from the ecological, political, economic, social and aesthetic points of view.

(vi) Developing a sense of responsibility and urgency, regarding environmental problems to ensure appropriate remedial action.

(vii) In the final analysis, to help improve the quality of life and bring fullness to it.

The formal and non-formal systems

At present, environmental education activity both in the formal as well as the non-formal systems, leaves much to be desired, being disparate and uncoordinated. In schools, environmental education is covered in disciplines such as : ecology, economics and social sciences. Some of the universities offer courses in environmental biology and environmental sciences. The agricultural universities and the Forest Research Institute and Colleges, Dehra Dun, at present, organise in-service training programmes on environment and ecology.

The annual observance of the World Forestry Day, the *Vanamahotsava* and the Wildlife week, throughout the country, is a part of the non-formal system of environmental education, which helps create awareness among the public in general and the youth in particular, towards preservation and development of our forests and wildlife and enlist their cooperation, through audio-visual publicity and instruction. The Publicity and Forest Extension Wings of the State/UT Forest Departments, need to be geared and satrengthened, to help impart environmental education on forestry adequately, under the non-formal system. Suitable material would need to be prepared for this purpose, for education through audiovisual means and distribution of material in concert with Department of Environment.

As a part of the wildlife week programme, essay and painting competition is organised for the schoold children, throughout the country. Besides, talks and debates are arranged and films on the subject screenedd. Visits of children to zoos, national parks and sanctuaries are sponsored and arranged, where, through nature trails and by first-hand experience, the various natural processes are interpreted and an appreciation for nature conservation stimulated. Publicity is also given through the medium of attractive posters and stickers, articles, feature and stories, in the press, and through the medium of the All India Radio and Doordarshan.

During the Wildlife Week of 1983, a nature camp-cum-workshop was organised for the teachers of the school in Delhi, who teach bio-sciences to the children. This was arranged over a period of one week. It elicited good response. The States were also advised to arrange such camps at various levels.

The regular nature camps programme, organised by the World Wildlife fund (India), supplements the efforts of the non-governmental organisations. It covers a large number of schools and children, through their year-round programme. The Gujarat Forest Department, also runs regular nature camps for school children, at their environmental education centre, near Ahmedabad. These efforts need to be emulated by others, so that they could cover similarly all other parts of the country. The National Wildlife Action Plan launched in 1983, recognizes the need for wildlife education and interpretation. The objective outlined thereunder, seeks to "promote and support wildlife education and interpretation, aimed at wider public appreciation of the importance of wildlife to human betterment".d In furtherance of this, a Centrally sponsored scheme, is being initiated from 1985-86, to aid and assist Central and State agencies to produce, disseminate and exhibit wildlife conservation publicity and educational material. The National Council for Educaiton, Research and Training (NCERT), has also taken on the task of revising the existing school syllabii, so as to better reflect, the different conservation concerns in various training courses.

For tribals and others, residing in and around forests, environmental education could be imparted, through the agency of *vani shibris* or forest camps. The main objective is to orient the teachers in this sphere, who could then pass on the message to the children. In 1984, during the Wildlife Week, the Wildlfie Institute of India organised nature camps, for about 300 school children of Dehra Dun, at the Rajaji National Park.

The general public is not aware of the environmental problems and their occurrence. There is an urgent need therefore to educate and enlighten the masses in this respect. The awareness and education must be acquired by the society, from programmes, that fall outside the formal education system, since the majority of the people, still do not have enough access to formal educaiton.

The role of Social forestry in Environmental Education

Social forestry which came into lime-light only about a decade ago, is a potent means, through which this awareness and education could be imparted. In the VI Five Year Plan, *Van Vigyan Kendras* were envisaged, through which it was proposed to demonstrate to and educate the people, on the important role of forests in their economy and therefore, as to how they should grow and rear trees and utilise them. Though this is essentially a programme of extension and training, its educative value from the environmental point of view, is no less. It is therefore proposed to extend this programme in a big way, in the VII Five Year Plan, so that it permeates the taluka and village levels in each district. The scheme; " A tree for Every Child" was initiated in the VI Five Year Plan, to help inculcate love for trees among the youth. The children in their formative years need to be initiated into the beauty and marvels of nature and of environment as a whole.

Integration of the formal and non-formal systems

We would need to bring about a proper integration synthesis, of environmental education, both under the formal and the non-formal systems, if it has to be purposive and meaningful. Environmental education would need to be suitably integrated in relevant disciplines, in formal education in schools and colleges. Unfortunately, this is not possible in the present circumstances in the case of forestry, which is not included in the curriculum in our schools, colleges and universities. Forestry education at present, is mostly confined to in-service training of those, who opt forestry as their career. In our forestry training colleges and schools, due emphasis is given in the curriculum, to the role of forests in environmental conservation. This education however, is restricted to the forestry personnel and is not imparted to the student world and the general public. A clear and determinate programme, needs to be evolved and implemented, bringing out clearly, the role of forests in environmental education. The current syllabii of schools and colleges, would need to be suitably revised, so as to include forestry as a component of environmental education and for this purpose, adequate teaching material would be necessary.

Measures are afoot, to introduce and impart completeness to forestry education, in some of the agriculture universities in the country. Similar measures, need to be initiated in other universities as well.

The focus of Environmental Conservation

Environmental education in order to be effective, should aim at covering the following major groups :

- Decision-makers and administrators,
- Youth, including children,
- People residing in and around forests and wildlife reserves, and
- General public.

The task of imparting environmental education to the youth, is of special significance, as the youth of today are the citizens of tomorrow. Any such effort, therefore, marks an investment, which may not have a visible impact today but the conservation principles imbibed by them, will manifest in their decisions and actions, as responsible adult citizens of the nation tomorrow. The Year 1985, is the 'International Year of the Youth'. It is this section of the society, where we most need, to direct our attention and efforts, at environmental education. This could be achieved both through formal and non-formal systems.

At the formal level, environmental concerns and more specifically, the need for conserving our forests and wildlife, need to be built into the regular syllabii of the courses at various levels in the schools, colleges and universities. Special courses could also be offered in natural resource management and in forest and wildlife conservation. Schools at all levels and colleges, should be encouraged to form nature clubs, so that regular field camps for nature apprehension and understanding are organised. Voluntary agencies play no little role in this regard and their services,therefore, could be fruitfully availed of. Orientation courses, for people in government and other decision-makers, whose actions may have an adverse impact on nature conservation, need to be regularly organised.

Man has come a long way, during the past centuries. The past, however, lives with him and biological processes of all species, including man, refuse to be hurried. Adaptation to new environmental conditions take aeons. We are still close to our beginnings, to ignore them and in spite of comforts and luxuries, we have never had before, we are conscious of tensions and pressures, are often uncertain and insecure and seem unable to make the transition. When the British historian Trevelyan said : "We are children of the earth and removed from her, our spirits wither", he spoke the truth. One has only to glance at the history of the human race, to realise the depth of his. belief.

If we are to survive, our philosophy of life, must be rewritten not in words or ideas, but in terms which would replant us firmly into the earth and under the shady tree, for "trees mean water, water means bread and bread means life".

SOCIAL FORESTRY IN INDIA

S.KONDAS
Chief Conservator of Forests
Tamil Nadu, Madras (India)

Agriculture, the Dominant Land Use

Agriculture, though at subsistence level, has been the settled occupation, rather way of life, for the majority of the people of the Indian subcontinent. Draught animals, mainly bullocks, continue tobe the main stay of motive power for agriculture and transport. The excessively large decrepit cattle population draining the land and grazing resources have come to stay as an important source of dung fuel. Next to rivers, the tanks, are an important source of irrigation.In the past rulers paid special attention to their maintenance and increased their number during 13-16th centuries and at the same time converted them progressively into river fed ones by a system of canals. In the state of Tamil Nadu alone there are 39,000 tanks irrigating a little less than a million hectares, a tird of State's total irrigated area. As water recedes to hollows on drawal for irrigation, tanks turn into grazing grounds and fishing waters. A tank is a feeling entity and an intimate appurtenance of rural India.

Forestry, remote public concern

In India for centuries the village system of administration with excellent maintenance of land records regarding different categories of lands and individual holdings by remunerated village officers has reached an extraordinary level of specialization and community participation. Agriculture though at low level of productivity has the involvement of the masses. As far as forestry is concerned it has remained remote in the public concern and a closed book to the people. The people generally adopted rapacious 'cut out and get out' removal attitude and stripped extensive areas of accessible forest cover notably in the plains in favour of subsistence agriculture and this is seen in the vast Ganga river basin where more than a third of India's population lives today. The ever receding forestline from habitation and consequent non-availability of wood fuel has made cattle dung, often available at door-steps, a much sought after domestic fuel.

Chronic scarcity of Fuel and Fodder

In the first few decades of their occupation in the 19th century, the British were keen on consolidating their gains and strengthening their hegemony. Their navy received considerable attention and the choicest teak went out from Bombay naval dockyard. After the Indian Mutiny of 1857, the British established nearly 11,700 km railway communication in twenty years for maintaining efficient movement of troops and supply. This had caused extensive forest clearance and strained forests for a regular supply of large quantities of railway sleepers and firewood as locomotive fuel. The USA witnessed similar developments in the thirties of 18th century but coal became the dominant railway fuel in 1870 and spared the forests. Further, petroleum fuels which had been gradually introduced in 1870 gained wide acceptance along with natural gas and hydro-electricity. By the turn of the 19th Century non-wood sources accounted for 89% of the BTU consumed. The ue of alternate fuels went a long way to conserve forests. In India the situation was different. Coal replaced wood as engine fuel only in 1906 and till then for nearly fifty years the overworked forests and natural thorny *Acacia* trees abounding in tanks had to bear the brunt of railway onslaught. As long as the railways were dependent on wood there were sporadic attempts of raising fuel plantations. Even this petered out after coal was taken as fuel. The innovative transport system, not much to the common good of the people, had worsened the fuel situation. Until the appearance of nonwood fuelss in quantity in the early 20th century, wood supplemented by cattle dung remained the main energy source. Even today cooking accounts for half of India's total energy consumption and 90% of it comes from fuelwood ,cow dung and crop residue. All these factors compounded the problem of supply of fuel, fodder, small timber and left it as one of chronic scarcity.

Voelcker's Report and Indian Forest Policy

The shortage was so patent that the Government of India, by a resolution of 1883, recommended even acquisition of lands for creation of village forests as a famine standby. Further as an incentive the Government introduced *tope* rule in certain parts for grant of rent free lands for 20 years to those who were willing to grow trees. Since agriculture had stronger claims no lands were actually made available.

In 1893 at the request of the Government of India Dr. John Voelcker, reporting on the improvements to Indian agriculture, strongly recommended the establishment and maintenance of local fuelwood and fodder reserves so that "if wood could be made to take the place of dung for fuel we should soon come to realise that manure means more crops and more crops an increasing revenue to the State whilst to the cultivators it implies more fodder, better cattle and more manure again to ensure future fertility of the soil. This recommendation, eminently valid even today, did influence Indian Forest Policy, 1894. But due to vested interests the recommendations and legislations remained only a distant mirage and in the words of one of the Inspector-Generals "for the last seventy years (since the days of Dr.Brandis) have remained laudable idea confined to forest literature and secretariat files" (1950).

National Forest Policy and Social Forestry

Hydrological and nutritional balance of the country clearly point out to the necessity of India having a third of the land area under forests with 60% in the mountainous tract liable to erosion and 20% in the plains where erosion is not serious and agriculture, the dominant land use. This was clearly brought out in the National Forest Policy, 1952 of independent India. Considering that fact that forests occupy only 22% of the land area of the country (75 m ha) an additional 11% (37.5 m ha) need to be planted up. Pastures and wastelands aggregating 80 m ha were reported to be available in the fifties. The National Forest Policy, 1952 envisaged a concerted move on the part of the Government and other agencies to expand tree lands outside regular forests through a scheme called farm forestry to increase supplies of grazing, small wood for agricultural implements and firewood. This would also release cattle dung for manure to step up food production. Putting it briefly it meant "establishing a tree crop on every patch of barren land, a grove of trees on every patch of gerrad, an avenue to mark every pathway, in Short a tree cover wherever there would be room for one to be planted. The scheme will not differentiate between public and private lands but will tackle lands neither without the people's consent and in any case will help clothe both equally with green vegetation of undoubted productive and protective value of the villagers".

Social Forestry through Five Year Plans (1951-80)

Inspite of so much of awareness all round serious attention was paid to social forestry, then called farm forestry, for the first time during III Plan period (1961-'66). With the enthusiasm kindled by the national *Vanamahotsava* movement it was felt that an effective beginning could be made under the then current community Development Programme and National Extension Service Programme covering nearly 5000 blocks for the entire country. To implement such a programme a good inventory of resources and needs at village levels was necessary.

For each development block it was planned to have a forester and forest guard who were expected to manage tree nursery for providing seedlings, to plant compact areas, assist every household and private farm holding on the best scheme for tree and shrub planting in his holding consistent with every other use to which he would put his homestead and his field, advise every village Panchayat regarding the choice of species, site, techniques for it to undertake planting along roads, paths.

As regards actual execution of works it was planned to plant the lake foreshores with fodder trees (*Erythrina indica, Dalbergia sissoo, Acacia nilotica, Inga dulce,Leucaena leucocephala, Sesbania grandiflora*), grasses (*Cenchrus cilliaris, Panicum antidotale, P. maximum, Brachiaria mutica*) and fodder legumes (*lecerne,* sun hemp etc.). In the *tankbeds. A. nilotica, A. planifrons, A. leucopholea,, Pongamia pinnata, Eugenia jambolana, Terminalia arjuna,* on the canal banks manure leaf species (*S. grandiflora, L. leucocephala, Glyricidia maculata*), along roads and paths shady and ornamental trees (*Mangifera indica, Tamarindus indica, Azadirachta indica, Bassia latifolia, Peltophorum peterocarpum, Samania saman*) and in field ridges nitrogen fixing trees (*A. nilotica, Glyricidia, Sesbania, Casuarina*), were to be planted.

Exclusion of Forestry from Rural Development Programmes

Rural development as carried out through the Five Year Plans is a comprehensive programme aiming to bring about an overall development of rural India covering resources and cultural and social aspects of community life. This is sought to be achieved through the fullest development of available human and material resources over an area basis and thereby raising rural community to higher levels of living with the active participation of people themselves. Although agriculture was given the highest priority forestry in general and form forestry (called social forestry in later years) in particular was not included as part of rural developmental activities in the III, IV and V Plans. While agriculture, animal husbandry, dairying, fishery made a good impact on the people, forestry remained largely a departmental affair. In retrospect,one finds that after 24 years of planned developmental activities during 1974, the total outlay on social forestry was Rs.19 Crores (US $ 19.0 million). Considering the extent of forests of 75 m ha, the magnitude of treatment which they require badly and the needs of the people it was too meagre. Understandably there is a greater appreciation in later years as seen from the larger though not substantial, allocation of Rs.52.2 Crores (US $ 52.2 million) during the V Plan (1974-'79) and Rs.351.9 Crores during the VI Plan (1980-'85). At the end of 30 years (1980) Social forestry plantations reached an extent of 1.43 m ha at a cost of Rs. 94.1 Crores (US $ 94.0 million).

Role of Foreign aid Agencies and Social Forestry

After the V Plan the Government of India and some State Governments considered to continue this programme with the support of foreign aid agencies like World Bank, SIDA (Swedish International Development Authority) USAID (United States Agency for International Devlopment), CIDA (Canadian International Development Authority). By 1983, programmes costing Rs.345.7 Crores (US $ 345.7 million) (contribution of the Aid Agencies in US $ 214 million) were in progress in eight States. The earliest programme was launched in 1979-80. Four more states have since been covered by foreign aided Social Forestry programmes costing Rs.158 Crores (US $ 158 million). The outlay and physical targets for 1980-85 will be Rs.352 Crores (US $ 300 million) and 1.26 m ha. Since the project is sanctioned the State Governments are committed to find initial funds. Training of personnel of various international institutions and interaction are possible since social forestry has become an international movement in many developing countries with foreign aiding agencies. A practical monitoring system has been built into each programme for corrective measure at the appropriate time. Whether a nation should be dependent on such aids to meet the basic needs of people requiring no foreign expertise or equipment is a question that needs serious consideration. It is hoped that such dependence may not be necessary as forest plantation develop self generating economy.

Tree Farming as the Forerunner of Social Forestry

Looking back to the 19th century, it is gratifying to note that extension forestry was initiated long before the addoption of scientific agriculture in India. In same parts of the country it succeeded for two reasons, namely the right choice of species and the timing of introduction. It was when the newly established Indian Railways were on the look out for a fast growing firewood species for the locomotives. *Casuarina* filled the bill admirably and the farmers seeing its potential and ready marketability took to its cultivation in the sixties of last century and this move on their own initiative could be well taken as the beginning of tree farming in India. Nearly a century later another exotic-*Eucalyptus tereticornis*, wormed itself into the affections of farmers due to its wider ecological amplitude and greater utilization. Gujarat State leads the country with increasing number of tree farmers, despite crusades and criticism against it. Where forestry tradition had not been particularly strong as in India tree husbandry of these two species had become a success because they had high *stakes* to offer to *individual growers* and proved themselves a gainful diversification of agricultural cropping.

Inspite of so much lead in extension forestry, at least in certain southern States, social forestry has not caught up with village communities and individual land holders as in the case of agriculture, dairying, animal husbandry. The valid criticism often made is that even after years of implementation, the programme remained largely a departmental affair without involving the people and voluntary organisations.

Shortcomings in implementation

The constraints are many and strong and they become evident while implementing in community lands like grazing grounds or irrigation tanks which are seldom free from encroachments or encumberances of other unauthorised land uses. By way of illustration, planting in tank can be taken up. A tank is a mixed bag of many land uses socially balanced over decades. As water recedes the tank turns into a scene of many life supporting activities. A section of rural poor wrests some sustenance by means of fishing. The village cattle, buffalows, sheep move in for herbage and fruit pods from scattered *Acacia* trees. The poorest of the poor seek edible tubers. The agriculturists remove silt, a well known soil amendment. Of late the landless encroach for seasonal cultivation of millets and vegetables and make quick money. Social forestry at the present high density planting tends to interfere with the existing uses and unsettle the established scheme of things. It is this that causes friction between the implementing functioneries and prospective beneficiaries. The planners and their field staff with good appreciation of rural sociology, basic agriculture, extension methodology will be able to impart the necessary dynamism and imagination to the programme. A suitably modified silviculture will fit well into the present system of land uses without steam rolling them. Right choice of species and planting density will improve grazing facilities. Low density planting enhance production of grasses, herbage and fruit pods on trees. Tree culture should meet the specific needs or even personal wants of target groups and not necessarily maximum volume production of firewood in all situations. It would appeal to villagers better if the harvest is made known in terms of goods they need most, like plough shares, spokes, felloes, tool handles, etc. Upkeep of plantations should provide for participatory management of developing community assets and villagers skill and not a mere opportunity for earning wages. If the object of management is production of goods, the service of villagers to cultivate trees for a specific pattern of growth will be necessary throughout. The harvest should be at a pace the villagers desire to utilize and not as a quick means of disposal through contractors agency. Implementation with good understanding in all aspects will transform the seemingly routine afforestation into one of powerful social performance.

Another reason for tardy progress in becoming a people's programme is the lack of information dissemination regarding economics of integration of trees into agricultural ecosystem, supposed adverse effects of trees on agricultural productivity, etc. Also field demonstration which proved a tremendous success in short-term agriculture proved difficult of comprehension in the case of long term forestry by the people.

In all programmes to step up production the biggest incentive to the beneficiary is built into the materials of supply like high-yielding cereals, milch cows, poultry birds, etc. The benefit is direct and specific. The kind of genetic grooming and technical refinement which influenced agricultural development since independence missed forestry. Trees are still in the aborginal state. Indian farmers used to improved strains in the wake of green and white revolutions no doubt, seek improved planting stock for gainful cultivation. Large scale production and supply of nursery stock (quality seeds, air layers from genuine superior parents) are absolutely essential to keep up the tempo of farm forestry (tree farming in private holdings). Seeds are the handiest of reproductive materials and the supply should be more and more of this kind instead of container/seedlings for handling. Good seed bearers preferably of vegetative origin should be raised as seed orchards in villages for easy availability of seeds. Once seeds of superior strains are readily available the shrewd Indian farmer will take to them giving the necessary momentum to the programme.

The New 20 Point Programme

By way of putting teeth in the Sixth Plan, Indira Gandhi announced a Twenty-Point Economic Programme giving due importance to afforestation, social and farm forestry and development of alternate energy sourcess with prospect of immediate tangible thrusts for various segments of population. The planting programme received the most needed boost.

Wastelands Development

One of the earliest and important announcements made in January 1985 by Rajiv Gandhi on his assuming the office of Prime Minister of India was the urgent need of bringing wastelands near villagers under fuel trees and pastures with large scale imvolvement of grass root level voluntary organisations, rural women and village bodies. A specially constituted autonomous body called 'Wasteland Board' will be in charge of implementation of a programme of nearly 50 million hectares at five million hectare per annum in the degraded forests and wastelandss outside forests with a total outlay of Rs.700 crores. The various rural programmes in force will take up the work besides State Forest Departments. As the task is expected to be massive the Government proposes to involve private nurseries on buy-back assurance. This countrywide programme will go a long way creating employment in addition to what has been created under foreign aided Social Forestry Programme.

Scope for Social Forestry Programme

The annual production of timber (sawn and round wood, plywood, pulpwood and matchwood) is of the order of 13.5 million m^3 as against the estimated requirement of 30 million m^3 in 1985 and 47 million m^3 by 2000 A.D. The present supply of firewood is around 103 million tonnes (73 million tonnes from forest lands and 30 million tonnes from nonforest sources) and still there is a gap of 47 million tonnes. The huge unmet demand will be a premium on the price of wood for many years to come and this should induce farmers to take up tree planting on a large scale providing, a great boost to Social Forestry Programme.

The fuelwood Study Committee of the Planning Commission (1982) located areas available under different categories for Social Forestry Programme. It is assured that out of 80 million hectares of wastelands comprising ravines, hard lateritic gravelly soils, saline/alkaline soils, sandy coastal areas, high altitude steep slopes, 12 million hectares would be available. They are problem sites, calling for more than normal inputs and the use of superior location specific planting stock. For strip or avenue planting about 202,000 hectares along 1,224,000 km of canals would be available. Of the total 143 million hectares under cultivation (43.5% of total area of the country), 68 million hectares under irrigation with a scope for further increase of 40 million hectares by 21st century, and 75 million hectares as much as the total forest area,under rainfed cultivation are available. These are the most important areas for social forestry to expand in coming years. The agricultural resources of irrigated areas are far in excess of annual cropping. According to one estimate the use of water in India is three times more that in Japan for producing the same quantity of rice. The excess resources can be put to good use of wood production, taking advantage of field bunds and planting rows of suitable species wide apart so as not to effect agricultural production adversely. Trees,being perennials, keep the lands productive even during fallow periods. Bund planting is likely to have another beneficial effect of checking the rise of water table, a common course of irrigated areas in certain parts of India. The Canal banks can also be planted with timber species and this programme, if carried out fully would bridge the timber gap. The remaining agricultural areas as well as road strips can be devoted to raising tree population of firewood and general amenities value.

Conclusion

The experience of three decades of implementation has served well in giving the programme, a new orientation, a viable strategy and a better involvement of people. They are spelt out below. It is essential to evolve and implement a multidisciplinary research programme for diffeent agroclimatic regions in order to investigate into :

(a) The interaction between trees of various species, population densities and spatial distribution on the hand and agricultural crops on the other and consequential overall return of agricultural produce, fodder, wood, etc.per unit or area and time.

(b) Tree farming techniques of suitable species of different densities and cost-benefit ratio for wastelands, community lands,etc.

(c) The simple technology of mass production of superior seeds and other planting stock for specific end use.

(d) The design of shelterbelts and their beneficial effect.

(e) Utilization of wood of exotic species. Such a knowledge will lend credence to the programme and strengthen the movement.

For the present a few empirical models in silvagriculture, silvipasture, tree farming can be designed for farm holdings and community lands and explained to the villagers for their consideration and adoption.

Forest Department should assume responsibility for supply of quality seeds and other planting materials like airlayers,etc. for some years to come. The villagers and farmers who have practiced scientific agriculture for over three decades will not find it difficult to raise all the planting stock. This is the first stage of making the villagers assume social forestry responsibilities.

The Panchayats under which the rural people organize and administer themselves, the cooperatives in economic spheres and schools are the basic institutions at the village level. They represent democratic decentralisation and grass root level contacts and should be taken advantage of for carrying out any programme. Family welfare programme was carried out successfully by these local bodies. Since they are the motivators, beneficiaries and administrators social forestry programme should take full advantage of them right from planning, execution, upkeep and disposal A programme of such a magnitude can be tackled only with their support.

Monitoring and evaluation

of social forestry programme is very important and the critical indicators are the physical and financial achievements, people's participation and socio-economic benefits derived from the programmes against objectives. The techniques of monitoring and the capacity of rural developmental institutions to handle it have to be quantitatively and qualitatively improved to ensure proper execution of this programme.

Seeing is believing and motivation lies in the eyes of the holder. Models of planting with improved stock of tree species within the resources of farmers as well as with increased inputs to demonstrate the benefits should be known widely.

Once convinced by demonstration landed farmers will take to farm forestry. Landless farmers who number many more can be motivated by suitable legislation or governmental directives conferring on them rights over trees and tree produce only without destroying it. If the right is made a hereditary one it will be a strong incentive. The problem is motivating people to tackle extensive wastelands and community lands. It is human nature to look for stakes in any venture. It the social benefits are specified in terms of goods which the villagers need most and not necessarily firewood always and quantified for a target group there will be much better involvement of the people in the upkeep of plantations. Tree farming cooperatives should be encouraged. The Government should supplement the people's effort by making a generous budgetary provision for social forestry in various rural developmental programmes under implementation.

SUMMARY

Forestry tradition had not been particularly strong in agriculturally oriented India. The issues of chronic scarcity of fuelwood and fodder and the necessity of raising village plantations were raised from time to time late 19th and early 20th centuries. Consequent to the National Forest Policy of 1952 emphasizing the necessity of a third of the land area remaining under forests a concerted move was made in the sixties to expand tree lands outside State forests. Although some beginning was made large scale programmes with the support of foreign aid agencies were launched in the eighties only. The criticism and constraints in the implementation are analysed. Considering the magnitude and complexity of the Programme it is obvious that further implementation will hinge heavily on the good organizational infrastructure namely the Panchayats, Cooperatives and village school developed during the passage of six Five Year Plans. The huge unmet demand for fuelwood and fodder will

place a premium on the price of wood for many years to come and this should sustain the tempo of the Programme. In the context of Social Forestry, wastelands and marginal lands of problems and low productivity are often thought of. In addition to these lands, agricultural lands aggregating 143 m ha (43.5% of total land area) particulary the underutilized irrigated lands of 68 m ha should be seriously thought of for gainful social forestry.

भारत में समाज-वानिकी

एस० कोण्डास

सारांश

कृषि उन्मुख भारतवर्ष में वानिकी की परम्पराएं विशेष बलवान नहीं रही। ईंधन-काष्ठ और चारे की भारी कमी और ग्राम रोपवन लगाने की आवश्यकता के मसले उन्नीसवीं सदी के अन्तिम भाग और बीसवीं सदी के आरम्भ में समय-समय पर उठाए गए। 1952 की राष्ट्रीय वन नीति बन जाने के बाद, जिसमें संपूर्ण भूमि क्षेत्र के एक तिहाई भाग पर वन लगाने की आवश्यकता पर बल दिया गया था सातवें दशक में राज्य वनों से बाहर वृक्ष लगाई भूमि विस्तार करने की लगनपूर्वक प्रयास किया गया। यद्यपि थोड़ा बहुत काम शुरू हो चुका था, विदेशी सहायता अभिकरणों की मदद से बड़े-बड़े कार्यक्रम नौवें दशक में ही आरम्भ कराए गए। क्रियान्विति की आलोचनाओं और प्रतिबंधों का विश्लेषण किया गया। कार्यक्रम की विशालता और जटिलता को देखते हुए यह बात स्पष्ट ही थी कि आगे इसका क्रियान्विति अच्छी संगठनात्मक अधोरचना पर ही प्रधानतः निर्भर होगी, जैसे पंचायतें, सहकारी समितियां और ग्राम विद्यालय, जिनका विकास छह पंचवर्षीय योजनाओं के दौरान किया गया है। ईंधनकाष्ठ और चारे की पूरी न की जा सकी भारी मांग आगे आने वाले बहुत सारे वर्षों तक लकड़ी की कीमत को बढ़ी हुए बनाए रखेगी और उससे कार्यक्रम की तीव्र गति भी बनाई रखी जा सकेगी। इसी के संदर्भ में समाज वानिकी, बंजर भूमि तथा समस्यात्मक एवं कम उत्पादक सीमान्त भूमियों की बात बहुधा सोची जाती है। इन जमीनों के अतिरिक्त लगभग 1430 लाख हैक्टेयर कृषि भूमि (कुल क्षेत्र की 43.5%), विशेषकर पूरी तरह उपयोग न की गई 680 लाख हैक्टेयर इसकी सिंचित भूमि पर लाभप्रद समाज वानिकी कराने के लिए गंभीरता से विचार किया जाना चाहिए।

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INFLUENCE OF POLICY AND LAW ON THE FOREST RESOURCES MANAGEMENT IN INDIA

K.M. TIWARI *

Introduction

India is one of the few countries which during the course of almost two centuries of recorded forest management have gone through the formulation of two National Forest Policies, one in 1894 and the other in 1952 and third revision is on the avail besides many forest enactments starting from 1865 to to-date. The present state of forests in India can be traced to have been brought about to a large extent as a result of National Forest Policy and various enactments.

There is hardly any literature available which throws light on the management of forests in India before the advent of British *raj*. However, it is possible to reconstruct the then state of affairs from the writings of colonial administrators themselves. In the pre-British time by and large the rural communities enjoyed unbridled use of the forests and wasteland in their vicinity. According to an official handbook of the Forest Department, under the 'oriental governments' that preceded the *Raj*, any one was accustomed, without let or hindrance, to get what he wanted from the forest, to graze his cattle where he liked and to clear jungle growth for cultivation wherever he listed.

The early history of forests

It was in 1800 when the East India Company appointed a Forestry Commission to make regulations prohibiting felling of young teak in Malabar forests (now in Kerala state) and in 1806 a Police Officer Mr.Watson was appointed the first Conservator of Forests in India for arranging exploitation of forests. In order to ensure future supplies in 1842 Conolly Collector of Malabar initiated along with his sub-Conservator Chathu Menon plantation of teak in Nilambur. In 1854, Dr. McClelland, Superintendent of Forests in Pegu, submitted a report to the Government of India suggesting certain restrictions on the unchecked exploitation of forests by private parties.

It was this valuable report which formed the basis of a

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Memorandum of the Government of India dated 3rd August, 1855, which may well be termed the 'Charter of Indian Forestry'. In this Memorandum, Lord Dalhousie, the then Governor-General of India, laid down for the first time the outline of a policy for forest conservancy. This pronouncement was an act of far-sighted statesmanship and marked the first concrete step towards scientific conservation of the forests. The early years of railway expansion saw unprecedented assault on the more accessible forests. Large chunks of forests were decimated to meet the damand of railway sleepers. In the absence any specific department no supervision was exercised over the fellings and many trees were felled which could not be utilised. The sub-Himalayan forests of Garhwal and Kumaon (Uttar Pradesh) were, all "felled in even to desolation" while "thousands of trees were felled which were never removed, nor was their removal possible". Private contractors both Indian and European, were chiefly responsible for this devastation.

Such large scale depredation awakened the colonial administration to the fact that India's forests were not inexhaustible. Railway expansion continued unabated and the methods by which private enterprise were working the forests forced the state to step in to safeguard their 'long term imperial interests'.

Report of the Government of India

In their despatch sent to the Secretary of the State the Government of India reported about the very unsatisfactory state of affairs that then existed. The following extracts taken from them is highly illuminating.

It will be convenient in the first place to refer briefly to the past history of forest administration by the Government of India, and to point out the steps by which matters have been brought to their present position".

"In Oudh a superintendent of forests has been appointed since the re-occupation of that province; from the latest information before the Government he is engaged in fixing the boundaries of the tracts of forest that are to be preserved and in preparing for their survey, which is going on at the same time".

"In the North-Western Provinces the difficulty of obtaining timber has been painfully felt for the last fifteen years or more, but the administration of the forests there up to the time of the mutiny was a melancholy failure. A superintendent was appointed in 1854 to the charge of the forests in the Dehra Dun and the west of Rohilkhand, the result of whose bad management was the completion of the ruin of almost all the forests that still contained good sized trees. At present the most important part of the North-Western Provinces forests is under the direct management of Lieutenant-Colonel Ramsay, the Commissioner of Kumaun, who has at last introduced order into the administration. But he works on the wreck of the forests, and it will take many years to restore them to a proper condition".

"It will be understood from this account that until quite the last few years no forest administration has in truth existed. Occasionally questions arose as to the proper system to follow, but they were taken up in that department of the Government of India to which they happened to be referred, and without any methodic or systematic policy. Hence at one time or place, forest management has been directly assumed by the Government, and at others the idea has prevailed that it is to private enterprise that the Government should look for the successful working of the forests of India. But so long as the supply of timber in the country was generally sufficient for the public works in hand, the question of forest management did not present itself to the Government as one calling for earnest consideration. Latterly, however, while the supply of timber has been steadily diminishing from want of proper conservation, the demand both for State and private purposes has been rapidly increasing; and the enormous requirements of the different railways for sleepers has especially brought the matter into very prominent notice, and has now made the subject of forest conservancy. an improtant administrative question".

"At length the Government of India perceiving the Great and increasing importance of dealing with its forests in a more regular manner, and of concentrating the administrative control, which till then had been exercised in a feeble and desultory manner in all the Civil departments, resolved to bring the consideration of all questions relating to forests before it in one only of its departments, and selected for the purpose that of the Public Works as being the one that actually had most frequently to deal with such matters, and that practically was most deeply interested in successful forest management".

"And in the first place we may express our belief, that under no conceivable circumstances is it possible that personal interests can be made compatible with public interests in the working of forests, otherwise than under a system of such stringent supervision as would, in fact, reduce those working under it to the position of mere agents of the administration. The length of time required for maturing a growth of timber is so great that no individual can have a personal interest in doing more than realising the largest possible present amount from any forest tract of which he may get possession. In fact, timber is produced of which no man can expect to get more than one crop in his life time, and the sooner and more completely he realises it the better. The moral or social restraintss that are likely to operate to prevent such a course are most especially wanting in India, whether we deal with natives of the country or European settlers. Therefore, we think that the idea of giving a proprietary right in forest to any individual should be abandoned, as the possession of such a right is almost certain to lead to the destruction of the forest; personal interest, in short, under existing conditions and in this respect are not only incompatible with public interest, but they are absolutely antagonistic".

"We consider also that all Government forest should be strictly set apart and made unalienable; of course, where private rights already exist, or where in the case of the forests of Burma certain rights have been conferred on private parties for a limited time, they must be respected, though it might be good policy to extinguish such rights on equitable terms whenever it be found possible to do so".

"It appears especially important, at the present time, when the subject of the disposal of waste land has been so prominently brought forward, to mark out and fix the boundaries of the forest which it is determined to conserve, so that it may be definitely determined what is forest, and what is wasteland, available for sale. We are sensible that the fact of the existence of a forest in India is, in many cases at least *Prima facie* evidence, that the land so occupied is not fit for any other purpose, and it is, therefore, necessary to be very careful about the disposal of wasteland containing forest tracts, until it be clearly ascertained that such land is susceptible of being brought under cultivation, that the grant is applied for this purpose, and that it is on the whole better to give the land up to be reclaimed than to preserve it as a forest".

"Of course, it cannot be said that any forest which is now thought to be necessary, or worth preserving, will be held to be so for all time; but the facilities for the destruction of forest are so great, the difficulty of reproducing it so insurmountable, and the general tendency in this country to accept as truth the fallacy that the clearance of forest is of itself necessarily an improvement so common, that it will be important to record forest boundaries, and to set forest land apart in a very strict and formal manner, and it seems even possible that the object might be attained by an act of the Legislature. But the exact way of doing this must be a matter for further consideration".

"When the forests are once removed out of the category of wasteland, and dealt with as a special State domain, there will be a very great step made in advance in obtaining for the forest administration a better defined position. The circumstance that forests have till now been reckoned as waste, and their produce treated as miscellaneous revenue, could not fail to be pornicious, and has very probably conduced no little to the present state of things. A primary object to a collector of land revenue is to remove land from the class that pays no revenue to that which pays, and his tendency will be to sacrifice forerst for cultivation. The idea that forest is a thing valuable in itself and, in truth, just as essential to the community as fields of wheat, sugar or cotton, took a long time to spring up, and, in fact, is not even now generally realised in that complete manner that is essential before forest management can be said to stand on a proper basis. The forests, when set aside as such, should be made to assume a distinct plan of their own in the departments producing revenue, and the success or failure of the administration should be made at once apparent from the state of the balance on the forest budget".

"We may add that it seems to us that as on officer will be specially required for the general control of forests under the Government of India, so also there should be for the several provinces chief local superintendents, such as Dr. Brandis is now in British Burma. In the minor administrations, where the nature of the forest tracts permits of tho work being concentrated, the principal executive officer may readily be general superintendent also. But in a province like Bengal, or in the North-Western Provinces, this could hardly be. The Local Government may probably be best allowed gradually to feel their way to some regular organisation, but of the necessity for system we have no doubt. It is true that occasionally a vigorous control may be exercised over the forests by a local revenue officer as has happened in the case of the Kumaun forests, where the administration of the Commissioner, Lieutenant-Colonel Ramsay, has been in a high degree successful. But such matters are not in their nature an essential part of his duties, and it is indisputable that when the success of the management of such a business is due to the special qualifications and peculiar zeal and activity of an individual officer, a change that removes him is but too likely to be followed by serious deterioration of system".

"Organisation to be of real and permanent value must not be essentially, or even mainly, dependent on extraordinary personal acquirements or activity; the machinery should be such as will work with average men under the direction of the best of their class. And this is peculiarly the case as regards the administration of forests. Results will be so long in coming, and ruin is so easily and so immediately brought about by the neglect of first principles by a single individual, that as little as possible should be left open to the local executive authorities in this respect".

The salient points of Secretary of State's reply is as follows:

"The present state of the forests, however much to be regretted, is not surprising in a country where forests were abundant, though difficult of access, where timber was in no great demand, and where on the other hand, land was in great demand for cultivation. Most countries of the world have suffered from similar neglect; and the results have shown themselves, not only in the dearth and consequent high price of timber, but very often in the deterioration of climate, and in the barrenness of land formerly culturable, situated at the base of hills, when these hills have been stripped of the forests that clothed them, which forests condensed the vapours into rain, and gave protection to the country below them. The subject, however, has of late been more considered, and the conviction has been arrived at, that it required the stability of a settled administration to prevent the present destruction of forests and hand them down in such quantity and conditons as to leave a due supply for future generations. A permanent Government only can be expected to wait long enough to reap the profit obtainable from an article which it takes eighty or a hundred years to bring to maturity. Permanency, as far as it can be obtained, is therefore of the highest importance in any arrangement for the due administration of forests; and Her Majesty's Government, therefore, entirely approve of your proposal to make a separate department at Calcutta for the control of all questions relating to forests in the provinces directly administred by your Excellency in Council".

"It is very satisfactory to me to learn that you have come to the same conclusion as Her Majesty's Government, that individuals cannot be relied upon for due care in the management of the forests, inasmuch as private interests must be opposed, in this instance, to the public interests".

The birth of Forest Department

And thus was born the Imperial Forest Department in 1864 with Dr. Dietrich Brandis as its first Inspector General of Forests. However, the task of checking the deforestation of the earlier decades and "consolidation of the forest estate" could not be accomplished without the assertion of State monopoly right over forest. It was in this dual sense that the railways provide to be the watershed with respect to forest administration in India- the need was felt to start an appropriate department and for its effective functioning the enactment of legislation to curtail the previously exercised unlimited rights of users was required. The latter feature marked the beginning of a progressive curtailment of these rights, and was an especially difficult task since it ran contrary not only to the traditional practices of villages and especially tribal communities, but also to earlier colonial agrarian policy in India. While, by and large, the British followed a *laissez-faire* policy that allowed the villagers to freely roam about in the forests and utilise its produce, there is also definite evidence from certain areas that "all land of every description was made over in absolute right to the community, subjects only to the yearly payment of rent fixed.

The first attempt at asserting state monopoly right was through the Indian Forest Act of 1865, which was replaced by a much more comprehensive piece of legislation 13 years later. The provisions of the 1878 Act ensured that the State could demarcate 'valuable' tracts of forest, needed especially for railway purposes, and retain enough flexibility over the remaining extent of forest land to revise its policy from time to time. Monopoly right was established by a legal sleight of hand, which sought to establish that the customary use of forest by the villagers was based not on 'right' but on 'privilege' and that this 'privilege' was exercised only at the mercy of the local rulers. Since the British were the rulers, the rights of absolute ownership were held to be vested in them. As one officer bluntly stated in 1873, "the right of conquest is the strongest of all rights- it is a right against which there is no appeal". The Act was the means by which the success of this sleight of hand was assured.

The enactment of Forest Act and formulation of National Forest Policy

The history of conflict and struggle can be seen essentially as emanating from alternative conceptions of property rights and obligations. There did not exist a developed notion of private property in these tribal and peasant communities where the relationship to the overlord was expressed in terms of mutual obligations which had to be fulfilled. Colonial rule, on the other hand, was based on a notion of private property that ran contrary to the experience of these communities. Moreover, the State dealt with its subjects individually in an impersonal fashion by the medium of an abstract rule of law that was theoretically neutral. As a consequence, the individual was now brought directly under the subjugation of the colonial state without the benefit of the mutual aid system of the community acting as a cushion. The tribals were confronted with the vagaries of the colonial market economy that continualy eroded their lifestyles - simultaneously, the assertion of State primacy over natural resources deprived them of an important subsidiary means of subsistence. J.V.Voelcker, an agricultural expert called in by the colonial authorities, summed it up thus: "The tendency of our system of Government has, to a considerable extent, been to break up village communities, and now for the most part they are heterogeneous bodies rather than communities".

The circumstances in which State monopoly right was asserted and the unrest in its wake brought to the fore the division within the colonial bureaucracy - a division between the revenue and law and order administration, on one hand, and the forest department on the other. This schism was based on antagonism of interest and differences of stand point.

The district officer,entrusted with the maintenance of law and order, was concerned at the discontent engendered by the new forest, the revenue-generating possibilities of forest land were not immediately apparent. The roots of this antagonism were succinctly stated by C.F. Amery in the first volume of the "Indian Forester". :

> "Upto a very few years ago the district officer had sole control of all lands in his district, and the unoccupied lands were his chief means of conferring patronage; he could give or lease them or confer or confirm privileges in them. If troubled with lawless tribes of *budmashes* he could offer them land as an inducement to settle to honest pursuits. And if a keen shikari, the forests were his sole and undisputed game preserves. Apart too from all departmental and personal interests, his stand point is different, his recollection carries him back to days when the forest as such yielded so little revenue, that it was often as well to let the people help themselves to its products and graze their cattle in it, as to be at the worry and cost of collecting the revenue; when every acre broken up for cultivation yielded more revenue than a hundred acres of forest land besides enlarging the capabilities of the district, and promoting the well being of the people; to a time when in fact the amount of forest broken up for cultivation became the recognized measure of a district officer's capability and tact".

Interestingly, the objections to the work of Forest Department though essentially relating to the increased threat to law and order, were often couched in more readily comprehensible terms, Voelcker, for example, criticising the Forest Department for not directly serving the interests of agriculture, advocated the creation of "Fuel and Fodder Reserves". He justified this policy on the grounds that, in the long run, any "possible diminution" of forest revenue "may be attended by increased revenue to the State from cultivated land".

The Forest Department on their part strongly resented the impediments put in their path by the district administration. The early years of the "Indian Forester" contain several attacks on district officials who, though knowing "nothing of forest matters", had an influence on forest administration out of all proportion to their knowledge and "steadily opposed the rational treatment of the forests". Another frequent complaint was that the district officers were reluctant to hand over forests and waste lands that came under the operations of the Forest Act - and when they did, the endeavour was to enlarge the record-of-rights to the fullest extent. Forests were thus un-necessarily burdened with rights to the detriment of the government's legitimate revenue".

The State's response to this division was to entrust arm of the bureaucracy with separate, apparently conflicting tasks. At the behest of Beden-Powel, one of the architects of the 1878 Act, forest settlements were effected in all cases by a land revenue or "civil" official, who was to ascertain the Forest Department's requirementsfrom the forest to be reserved, and then see "how far these requirements can be met". The civil officials, in addition, were to be in charge of the punitive sanctions of the forest Act, so as to "prevent any further interference with the people than i necessary for efficient protection". This 'carrot and stick' approach was called for by the 1894 resolution on forest policy, one necessitated by the "strict forest administration which has prevailed of late years (and) has given rise to serious discontent among the agricultural classes". This more 'lenient' policy, ostensibly dictated by considerations of serving the peasantry more directly, asked for more liberal provisions of fuel, fodder, grazing etc. However, this provision for local requirements was to be made only "to the utmost point that is consistent with imperial interests".

Main features of the 1894 policy

The Government of India were guided by the following :

(1) The sole object to which the management of forest is to be directed is to promote the general well - being of the country;

(2) The maintenance of adequate forests is dictated primarily for the preservation of the climatic and physical conditions of the country and, secondly, to fulfil the needs of the people.

Subject to these conditons:

(a) Permanent cultivation should come before forestry;

(b) The satisfaction of the needs of the local population at non-competitive rates, if not free, should over-ride all considerations of revenue;

(c) After the fulfilment of the above conditions, the realisation of maximum revenue should be guiding factor.

The Government-owned forests were classified with reference to their primary functions, as follows :

(i) Forests, the preservation of which was essential on climatic or physical grounds;

(ii) Forests that afforded a supply of valuable timbers for commercial purposes;

(iii) Minor Forests; and

(iv) Pasture lands.

The above classification was not intended to be rigid and a particular forest night fulfil more than one function.

This forest policy, which guided colonial administration upto 1947, envisaged the benevolent paternalism of the district official acting as an arbiter between the Forest Department and the people. Closer co-operation and constant consultation between the Forest Department and revenue official was urged the maxim prescribed for the forest officer was on of *festina lente* (hasten gently) even if this involved a deviation from perfect measure of regeneration or the extraction of trees for local use over and above that laid down by the record of rights. As the same time it was stressed that the detailed application of these principles must depend on local conditions - whenever concessions were granted to the local population (such as the throwing open of reserved forests for grazing), it was best to make them for a limited period say 10 or 20 years so that they could be reviewed as circumstances changed.

Main drawbacks of the 1894 policy

After India became independent in 1947, it was considered necessary to restate its Forest Policy. While the fundamental facts emphasizing the need for conserving the forests as stated in 1894 Policy were still true, the concept of management had changed in as much as :

(1) The population, both human and bovine, had gone up substantially and, therefore, the demand for forest products and for land for cultivation has increased.

(2) Many industries utilizing forest products had sprung up and others could be established.

(3) New uses had been found for certain forest products previously considered valueless.

(4) The Policy of 1894 was applicable to the forests under the management of the Forest Department, with the result that other Government-owned lands were not covered by it. Control of the management of private forests was also to be provided for in the new statement of forest policy.

(5) It was necessary to manage systematically the forests forming the catchment of important rivers.

(6) It was considered desirable to combat the menace of shifting cultivation.

(7) As wild life is an integral part of the forests and a valuable asset, it is necessary to lay down a suitable wild life policy.

(8) It was necessary to spread the message of forestry amongst the people to convince them that their welfare depended on sucessful forest conservation.

(9) Besides this it was also considered desirable to emphasize the need for managing the forests on the principle of sustained and, where possible, progressively increasing yield of produce most in demand.

(10) It was considered desirable to specify that forests should be classified on the basis of functions they are to fulfil as :

(i) Protection forests,

(ii) National forests, and

(iii) Village forests.

(11) The claims of neighbouring communities should, in no event, be admitted at the cost of jeopardising national interests.

(12) The policy should give a definite indication of the extent of forests in the country as a whole and in particular tracts that would constitute a minimum, and should lay down steps that would lead to this ideal.

(13) Lastly it was considered desirable to emphasize that Government should provide the best facilites for training in Forestry and for research in the various aspects of forestry, as also maintain a liaison with the industries utilizing forest products.

National Forest Policy of 1952

After independence, it was considered necessary to revise the forest policy. It was felt that "the revolutionary changes which have taken place during the interval in the physical, economic and political field called for a reorientation of the old policy". It was stated that the value of forests was recognised not only in the physical field, such as conservation of moisture and prevention of erosion, but also in the economic field, such as development of agriculture, industry and communications. Th post-war reconstruction schemes also involved industrial expansion, river valley projects and development of communications, all of which leaned heavily on the produce of forests.

The National Forest Policy was revised in 1952 and was issued as a Resolution of the Government of India. It proposed the classification of forests on a functional basis into protection - forests, national forests, village forests and treelands. It emphasised the need for evolving a system of balanced and complementary land-use, under which each type of land was to be allotted to that form of use under which it would produce most and deteriorate least. The Policy considered it desirable to establish treelands wherever possible for the amelioration of physical and climatic conditions, and for promoting the general well-being of the people. It also made provision for ensuring progressively increasing supplies of grazing, timber for agricultural implements and firewood to release cattle-dung for use as manure. The national policy also discouraged indiscriminate extension of arable land by the excision of forests, as this not only deprives the local population of wood, grass, etc. but also deprives the land of its natural defence against dust storms, hot wind and erosion. It emphasized that the notion widely entertained that forestry as such has no intrinsic right to land, but may be permitted on sufference on residual land not required for any purpose, has to be combated. The role of forests, productive, protective and bio-aesthetic, entitles them to an adequate share of land to promote public well-being and ensure the balanced economy. The policy also laid down that it would be the duty of the forester to awaken the interest of the people in the development, extension and establishment of treelands wherever possible, and to make them treeminded. The national forests were to be managed on the principle of progressively increasing sustained yield to meet the requirements of defence communications and industry. It also emphasised the need for affording protection to wild life by its proper management for scientific study and for recreational purposes. The policy laid stress on (a) weaning the tribal people, by persuasion, away from the baneful practice of shifting cultivation, (b) increasing the efficiency of forest administration by having adequate forest laws, (c) giving requisite training to the staff of all ranks; (d) providing adequate facilities for the management of forests and for conducting research in forestry and forest products utilisation; (e) controlling grazing in the forest; and (f) the need for promoting the welfare of the people.

Large Scale Disforestation

Inspite of the laudable principles enunciated in the 1952 policy large areas of forests have been cleared for extension of agriculture during the past three decades. It is unfortunate that the categories of land containing village forests not under the control of forest department were recorded either as miscellaneous tree crops and groves or in many cases as culturable wastelands. These so called miscellaneous tree crops and wasteland which were actually forests were not covered by the provisions of Forest Acts as such their clearance has gone at the sweet will of the revenue department. During the last 30 years more than 25 million ha of such miscellaneous tree crops and groves (16 million ha) and culturable wasteland (6 million ha) have been cleared and brought under plough. Of the reserved forest out of 75 million ha only 4.3 million ha have been diverted towards extension of agriculture, reservoirs, rehabilitation and other industrial uses.

The greatest damage to forests in India was perpetrated soon after independence. When the princely States merged in the Union, large scale felling took place in the princely forests. Similarly, when Zamindari (land lord system of land tenure) Abolition Acts were passed in many of the States round about 1950, most of the private forests were recklessly felled. There are no exact records to show the correct acreage, but it will run into millions of ha of forests in the country. Indeed if our law makers of the time had added a clause in the Zamindari Abolition Act, "that the forests shall not vest in the Government", the existing private forests would have been saved.

Where the policy failed

We must be thankful to the early foresters who enacted the forest laws and constituted the reserved and protected forests but for this what little (75 million ha) forests we have in all probability would not have been there. In retrospect it appears rather baffling while the Govt. of India did recommend to Secretary of State that forests must be managed as a public property and the then Secretary of State did agree with this view and yet large tracts of forest were left without reservation by early foresters presumably for the unfettered use of the villagers. Indeed our National Forest Policy failed on this point. Large chunks of village forests should also have been reserved with a specific manipulation that all usufruct from such forests shall accrue to the villagers and that such forests also shall be managed on the principle of sustained yield in perpetuity by the forest department. In case of this category of forests, the forest department should have acted as a service department for the villagers. In most of the village forests now being created under Social Forestry Programmes, this provision is being laid down. Indeed had there been no supremacy of the revenue officers in running the administration of the country, this would have been enforced long ago. Already the country has paid heavy price due to this. In the Himalayan region of Uttar Pradesh approximately 6,000 sq km of what is known as civil and soyam forests were under the charge of revenue officers. Ignorant of the principle of sustained yield in perpetuity revenue officers allowed unrestricted fellings in this for the reasons shown in page 906 with the result that these forests are now vast expense of treeless and barren hillsides The general public including host of environmentalist who do not know the details, think that it is due to inefficiency of the forest department. This sorry state of affairs has happened in many other States of our country. Even now we have in our country approximately 20 million ha of such forests under the recorded category of miscellaneous tree crops and culturable wastelands. And believe it or not exactly for reasons stated about 100 years ago by C.F. Amery (Page 906),the revenue officers are not prepared to hand them over to the forest department for management.

Having finished most of the village forests, the onslaught is now on the Reserved and Protected forests particularly those which happen to be situated along the habitation. This has brought the forestry personnel in direct conflict with the public. It is now realised that in order to save these forests, massive programme of afforestation under Social Forestry Programme in the degraded forest area, village wasteland and other vacant public lands including planting of trees on field bunds of private cultivation is the only alternative, so that the villagers are able to get their basic requirement of fuelwood, leaf, fodder, grass, small timber etc.

National Forest Policy- A Case for further revision

Since the enunciation of this policy in 1952, developments of far reaching importance have taken place in the economic, social and political fields. Increase in population has given rise to diversified demands for a great variety of forest products one the one hand, and has built up heavy pressure on land on the other hand, resulting in substantial loss of forest land. In the silvicultural and management techniques and in technological and industrial fields considerable progress has been registered opening avenues for further expansion and integration of forest based industries. The economic and social benefits accruring to the community from forest and forest based industries have come to be better understood as also the role played by forests in conserving soil in the catchments of rivers and river valley projects. The basic objectives of the development plans have been : removal of poverty by generating economic growth and employment, balanced regional development and self-sufficiency in the matter of products of daily use. As self reliance is the fundamental objective of future economic and industrial development, there is need for the concept of multiple use of forest lands, greater attention to increase the productivity of forests and their scientific management on modern lines. Thus while the fundamental concepts underlying the existing forest policy still hold good, it is felt that in the light of changes which have taken place since its enunciation, the forest policy has to be reoriented.

Imperative in new forest policy

It is really a paradox of our times in our country that a minority of affluent class not directly benefitted by the forests are crying hoarse to save the forests while millions of poor people who make their subsistence living from the forest are bent upon destroying them by their unrestricted and unscientific removal of forest produce, uncontrolled excessive grazing and lopping and putting the forest on fire for getting new blades of grass. Sometimes persons ignorant of the Indian social milieu of our people advocate that forests should be distributed to forest dwellers or communities for management and preservation. As will be amply clear from the experiences of many countries mentioned in this paper such a step will mean total destruction of the forests. But all the same the forests cannot be saved without people's direct involvement. It is my personal opinion that in order to drive home the idea that forests are their real benefactor and that the survival of the coming generation depends on the maintenance of the forest, the forest policy may lay down that all revenue accruing from the management of such forests shall be earmarked for the benefit of the poor people - the real user of forest - so that they look upon the forests as if it is their own. Once the sense of belongingness is created in them, main hurdle in scientific management of our forests will have been removed. But it is an herculean task to manage the forests by a Government Department and yet create a sense of possession in the villagers. It is a challange to the new generation of foresters. May be that this is impracticable at the moment but a beginning to achieve this has to be made without any loss of time.

Present status of Forest Laws

Forest legislation dates back to 1865, when the Indian Forest Act was enacted. The Madras Presidency formulated its own Act - Madras Forest Act, 1882. Until a comprehensive Indian Forest Act was formulated in 1927, the following Acts and amendments concerning forest management in British India outside the Madras Presidency were enacted :

(i) the Indian Forest Act, 1878;
(ii) the Forest Act, 1890;
(iii) the Amending Act, 1891;
(iv) the Indian Forest (Amendment) Act, 1901;
(v) the Indian Forest (Amendment) Act, 1911;
(vi) the Repealing and Amending Act, 1914;
(vii) the Indian Forest Amendment Act, 1918;
(viii) the Devolution Act, 1920.

At the time of formulation of the national forest policy in 1952, forest legislation existed in the Indian Forest Act, 1927 (hereinafter referred to as the Act) and the Madras Forest Act, 1882, so far as the forests under the control) of the Central Government and of the then Part A States were concerned. In some of the Part B States, there were forest regulations having the force of law and in some Part C States forest law did not exist at all. In pursuance of the recommendations in the 1952 policy, some of the States enacted their own full scale forest Acts and some extended the provisions of the Indian Forest Act to their territories.

In 1962, the Central Boards of Forestry (CBF) recommended that the suggestions for improvements and changes in the Indian Forest Act in the light of recent development might be invited from the State Governments, and a proposal for the amendment of the Act in the desired directions should be drawn up. The suggestions of the States/Union Territories were examined by the Standing Committee of the CBF in June, 1963. The Standing Committee set up a sub-Committee to consider the question of amendment of the Act. The CBF considered the report of the sub-Committee in December, 1963 and recommended as follows :

> "It was decided that the recommendations of the sub-Committee as modified by the Ministry of Law and the Ministry of Steel, Mines and Heavy Engineering be forwarded to the State Governments who should initiate action for amending their Forest Acts".

The issue in one aspect of forest management, viz., nationalisation of trade in various minor forest products, came up again for discussion before the CBF in February, 1973. In order that there may be uniformity in respect of this legislation, the CBF recommended revision of the Act.

State control of Private Forests

The Great War awakened most European nations to the need of conserving their forest resources so as to be self-supporting in the event of an emergency. Attention naturally came to be directed towards private and communal forests whose management was subjected to a progressively stricter control. In Soviet Russia, private forests disappeared with private property. The Fascist and Nazi regimes tightened up control on private forests to the extent of making them indistinguishable from State forests. Compulsory expropriation of private woodlands was resorted to in Czechoslovakia and Baltic States. In the U.S.A. the Weeks Act of 1911 registered the reversal of the alienation policy which had accounted for 80 per cent, of forests being under private ownership. Later, the Copeland Report of 1933 recommended the acquisition by the state of 134 million acres of forest in the U.S.A. The communal forests in Europe and Africa have always been under State supervision.

Great Britain, with its lowest proportion of forests in Europe, pursued the policy of *laissez-faire* towards private woodlands,due to the facilities she enjoyed for importing her timber requirements. As a result of the Acland Report, the Forestry Act was passed in 1919, constituting the Forestry Commission. Thereafter, the State or Crown forests steadily went up, amounting to over a million acres in 1937. In the same year private woodlands in Great Britain amounted to 86.4 per cent of the total forset area, which is the highest proportion of privately owned forests in the world. State assistance to private forests under the Forestry Act of 1919 took the form of grants, free technical advice, contributions and susbsidies for educaiton and research.

The post-war policy of Forestry Commissioners with regard to private woodlands in Great Britain stresses the need of their rehabilitation immediately after the war ends. Neglect of woods exploited under the exigencies of the World War would mean their total extinction. The Commissioners have therefore, proposed a 'Dedication Scheme' whereby an owner dedicating his woodlands for the specific purpose of timber production would get a State subsidy until they become self-supporting. The undedicated woodlands, the Commissioners propose, should be acquired by the State. The management of dedicated woodlands would be under the supervision of the Forest Authority, which will assume complete control on terms fair to both parties in the event of dedication breaking down. The dedication of woodlands would remain unaffected by changes of ownership. That such a revolutionary proposal should emanate from the citadel of the liberty of the individual is an indication of how private ownership of forests would be subordinated to the interest of the community at large in the post-war world.

In India, private forests attracted attention in the past largely because of their role in the control of erosion, floods and soil denudation. The provisions of the Indian Forest Act were of no avail in saving private woodlands from reckless destruction and consequent denudation of surrounding lands. In Chota Nagpur and Orissa, the destruction of private woodlands had reached the stage that a committee, with Mr.H.L. Stephenson as its president, was appointed in 1908 to devise ways and means for arresting further denudation of the countryside. The report, which the Stephenson Committee submitted in 1909, included a draft bill for the preservation of private forests largely on physical and climatic grounds as the repealing of section 37 of the Forest Act was not considered enough. To ensure continuity of policy special civil forest officers under the dual control of the conservator and the commissioner concerned were proposed. Expenditure incurred on the technical personnel and the maintenance of doundaries was to be met by the State. The control was to be kept invisible and the State interference as little as possible. The proposals of the Stephenson Committee met a fate no better than that of recommendations made earlier by Hewitt, Schlich, Campbell and others. Soon the report was lost sight of and forgotten. The question again came to the forefront in 1939 when the Chota Nagpur Private Forests Bill was drafted and referred to a Select Committee. In the meanwhile the Congress Government which sponsored the bill resigned. Nothing has been done ever since and the war has further accentuated the depletion of private forests. In Bengal the bill drafted by the special committee appointed for the purpose made no headway either and was finally shelved. Neither the Punjab Land Preservation Act II of 1900 nor the Bombay Act No. XXVIII of 1942 provides the necessary legal machinery for the control of private forests unless their preservation can be justified on climatic and physical grounds.

While State control of private woodlands on physical and climatic grounds is justified in the interest of the common weal and legislative machinery such as the Punjab Act or Chapter V of the Indian Forest Act has been provided for the purpose, the recognition of State interference in the matter of management of private treelands run on commercial lines is still lacking. It does not seem to be sufficiently appreciated that forestry, unlike agriculture or industry, represents a long-range investment often well beyond the limited span of human life. Naturally, therefore, forestry does not inspire sustained interest in the individual. The prospect of quick returns being absent, owners are often tempted to sacrifice their capital for an immediate gain. Sport often provides a better incentive for the preservation of forests than profit. The time factor involved in forestry militates against the sound management of private woodlands. The State alone can take a long-range view as a custodian of forest wealth in the interest of generations born and unborn. It must preserve treelands as a national asset, not only on climatic and physical grounds, but for their role in the rural economy of India. The management of private forests must however be geared to the integrated utilization of lands and should not be considered as an isolated problem.

Approach to Forest Legislation

A general view is held that forest law has not been conceived as a positive agent of development but merely as a means of preventing the misuse of the forest. It has been considered not in terms of its general constructive function, but chiefly in terms of litigation. It has been stated that forest regulations are regulatory and punitive and follow a definite pattern and form. Thus in a typical enactment, clauses constituting various types of forest resources, defining different categories of protection in the forest estate,empowering the Conservator and his officers to do a number of things outside the common law (issue leases, licenses and permits, arrest without warrant, compound offences, prohibit the felling and transportation of timber), and defining forest offences and their penalties,were to be found.

According to the revised FAO study, the object of all laws reelating to forestry in the modern situation should be the promotion of forestry and forest industries activities so that the forest resources might be utilised for the general economic development of the nation. King* suggests that a more functional a more developmental approach should be adopted towards the forest laws. With this in view, the laws will have to be revised from time to time as socioeconomic conditions and tehcnology change. "It may therefore be advisable to frame the present forest law in such a way that its provisions are skeletal but that it authorises in clear terms a well-defined authority to enact subsidiary legislation, in specific circumstances, by rule, regulation, law or order. Amendments to subsidiary legislation can often be comparatively easily performed, and it is here that the details should be included".

Conditions in India are such that there cannot but be a relatively more emphasis on preventive and punitive aspects and enhancement of penalities in any revision of the forest law. The following principles should govern any revision of forest legislation :

(i) There should be a unifromity in forest law, so that incompatibility of forest laws among the States is removed and there is no multiplicity of legally sanctioned authorities concerned with forestry matters;

(ii) it should be possible to

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* King, K.F.S., 1972. A Summary of the Revised FAO Study on Forest Policy, Law and Administration, Rome, FAO.

tackle specific problems in different parts of the country through subsidiary rules and regulations, where permissible;

(iii) a developmental approach should be followed; and

(iv) there should be stringent preventive and punitive provisions, so that when a resource is allocated for development in a certain direction, it is not wasted.

Conclusions

Experience gained in India from the application of National Forest Policy and enforcement of various Forest Acts during a period of more than hundred years brings out one fact clearly that, however, meticulously a policy may be drawn or an enactment may be made, if it does not take into account the socio-economic conditions of the people at large, it has no chance of success. A policy or enactment on forests will be as good or bad as the people themselves The modern forester has not to be a technically trained forester only, but he must have sufficient knowledge of the socio-economic conditions and attitude of the people at large. In many situations what is most scientific and profitable is not practicable and for success it is the latter that matters. We hope the forthcoming generation of foresters will successfully tackle these complex problems.

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WASTELAND AFFORESTATION

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Introduction

The Consultative Committe of Parliament chaired by Prime Minister of India in its meeting of August 23rd, 1985 has stated 'India has a land mass of approximately 329 million hectares. Estimates are that atleast half of it is degraded, whose productivity is far below its potential. The board sub-divisions of degraded land resources are (i) in agriculture, out of 143 million ha., atleast 40 million ha. or so are degraded; (ii) in the forestry sector, out of 75 million ha., 30 million ha are without tree cover and 10 million ha have some shrubs only; (iii) the pasture and grazing lands and other uncultivated lands are largely degraded. We have approximately 175 million ha of degraded lands in the above categories. Amongst the majer uses of land-agriculture, forestry and grazing-grazing lands have been the most neglected and are perhaps the most degraded areas.

Wastelands definition

There is no well accepted definition of wastelands. Bhumbla uses the following definition "Those lands are wastelands which are (a) ecologically unstable; (b) whose top soil has been nearly completely lost and (c) which have developed toxicity in the root zones for growth of most plants, both annual crops and trees". This will cover all lands affected by water erosion, wind erosion, floods, water-legging, soil salinisation and soil alkalinisation. The snow clad mountains, bare rocks and geologically unstable area are also wastelands.

Formation of Wastelands

Majority of wastelands have been formed due to misuse or overuse. The live stock population in India increased from 284.6 million in 1959 to 358.5 in 1977, an increase of 26% in 26 years. The goat population showed a 60% increase during this period. This huge mass of live stock needs fodder and there simply isn't enough of it. Only about 13 million hectares in the country are classified as permanent grazing lands. As these are obviously not enough, and exist in a highly degraded state, the animals scourge for whatever they can get on millions of hectares of fallow and uncultivated lands and uncultivable wastelands, as well as 36 million hectares of tropical forest lands. In all, almost all accessible vegetation in more than half the total land area of the country is grazed by live stock-which snap up everything except non-palatable weeds.

It is interesting to note that in U.P. the extent of degraded lands did not show any change from 1911 to 1940 (Chaturvedi 1946), However the extent of wastelands have increased from about 8 lakh hectares in 1940 to 12 lakh hectares during 1984, an increasing of 50%. The main reason is the utter disregard to ecological considerations. The increased human activities in shape of mining, road constructions, extension of agriculture, erosion and seepage due to irrigation canals are mainly responsible for this increase.

Afforestation methodology

Afforestation of degraded lands provides the best use of these lands. Covering of these lands with vegetation prevents soil erosion, conserves water, removes excessive salts, restores soil microbiological activity, increases percolation, lowers soil temperature and increases the agricultural productivity of adjoining lands. Methodology of afforestation is however, site specific. Some of the more important degraded lands are usar lands, ravines, hill slopes, areas of seepage water, coastal areas, river banks and areas of blackish water. Different types of degraded lands call for different techniques for afforestation. Every situation calls for in depth study of the causes which will provide methods for afforestation.

1. *User lands* : User soils include saline, sodic and alkaline soils. These soils are met with on hard clay as well as on sandy tracts. Intermediate stages can also be met.

Sandy soils with high pH can be found along major rivers. These soils are characterised by pH range of 9 to 10, severe drought during summer months and high temperatures upto 45°C, heavy frost during winter months with temperature going down to 0 °C, annual flooding during rainy season, repeated fires, sand drift with strong hot winds (two) during summer months. Annual flood removes excess salts on the surface and deposits fine fertile silt. Any afforestation technique should consider the special conditons and take advantage of the silt deposition. No afforestation is likely to succeed without providing adequate irrigation during the summer and winter months. The species should be able to withstand frost, tolerate high temperatures, cast a heavy shade to suppress grasses and check surface evaporation. The species should possess thick foliage on stem to combat the drifting sand. A combination of species will be able to meet these requirements. Planting pattern should be Poplars at 5 m interval in rows that are 4 m apart. In between two consecutive rows of Poplars there should be a row where *Terminalia arjuna, Haplophragma adenophyllum, Pongamia pinnata, Syzygium cumini* and *Dalbergia sissoo* should be planted. Irrigation is easy with shallow tube wells and must be provided before starting planting. The area should be ploughed and harrowed soon after the rains during October-November. Low ridges (about 20 cms. high) should be made. Planting should be carried out in the channel between the ridges. The width of channel should be 30 cms. This will facilitate irrigation along the channel. Irrigation will be needed once a month during winter months and once a week from March till the break of monsoons. Correct Poplar clone should be selected. *Poplar deltoides* clones G-3, G-48, S C and S C have been found promising so far.Termites are a serious pest on these soils.0.1% solution of Aldrin,Aldrex or Heptachlore have found to be effective. Poplar ETPS should be soaked in anti-termite solution for 24 hrs. before planting. Bags of all other species should be thoroughly soaked with such solution before planting.

In case of loamy soils role of calcareous deposits (Kanker) is very significant. These lie some times on the surface while at other times they are seen in thick layers deep down. The size of the *Kanker* nodules as well as the thickness of the pan is also variable. Where the thickness of the pan is small and *Kankers* lie within one metre of the surface it will be economically feasible to remove them. Where they are in deeper layers it is uneconomic to remove. Use of earth augers to break the *Kanker* pan is beneficial in soils that have lower percentage of clay otherwise the circular movement of the augur creates a tangential force which compacts the sides and regards the lateral development of roots. The plants stagnate in growth after showing promising growth at early stage. Manual digging of pits is most desirable in these situations. The size of pits should be 60 cm x 60 cm and 90 cm deep. Spacing will very with species but a spacing of 2 m x 2 m is good in most situations. A closure spacing is not desirable due to the poor status of organic nutrients in the soil. The specialities of these soils are low permeability of water causing water logging during rainy season, poor drainage hot winds during summer months, severe frost in a cycle of 4 or 5 years, soil alkalinity varying from neutral to highly saline. Due to higher concentration of inorganic salts and heavy soils the root development of plants is very slow. The root system of plants takes two to six weeks to establish on new planting sites. The roots are not fully active during the period and are liable to rot if water-logging takes place during this period. Rainy season is not the right time to plant on sites where water logging is expected. Planting should be done after water logging conditions disappear. In North India October to February are better months on such sites except that periods of frost should be avoided. Irrigation is essential for success on such sites. Choice of correct tree species is essential for ensuring success. The species have to be such that they tolerate temporary water logging and have a lateral root system. The species should be able to tolerate both frost and drought and should preferably be Nitrogen fixing and deciduous during winter months. Promising species for planting are *Prosopis juliflora, Acacia nilotica, Albizia lebbek, Albizia procera, Cassia siamea, Cordia dichotima, Haplophragma adenophyllum, Dalbergia sissoo, Pithecolobium dulce, Pongamia pinnata, Terminalia arjuna* and *Syzygium cumini.* Weeding is a harmful operation on user soils. Soon after protection is provided and soil working and irrigation are started, some grasses and weeds start occupying the ground. These weeds tolerate the high alkalinity and salinity of the site. They cover the ground and provide organic matter to the soil. Many of the weeds are leguminous and fix Nitrogen. Field observations show that many plantations have failed due to intensive weeding on such sites. Weeding should not be done on such sites unless it is definitely needed. in which case they should be cut ther than uprooted.

1. *Seepage along Canals*: Canals flow above the general ground to provide irrigation by gravitation. In certain types of soils this water seeps and the water table of the surounding areas rises. The rise in water table increases the concentration of inorganic salts and new *Usar* lands get formed. Where slopes are good the water can be drained out through drainage channel but in most conditions viz. Eastern parts of U.P., where land is more or less flat there is not enough gradiant for the flow of this water. No system of drainage can therefore, succeed. Afforestation provides a viable method to combat this problem. If the area is planted up the trees will absorb the water, utilise part of it in growth and transpire the rest in atmosphere. The salts contained in this water will be party utilised by the trees and party diluted through the addition of leaf litter. The trees will keep the ground covered and reduce evaporaton. The decaying roots will increase the porosity of the soil. The upward movement of salts will thus be reduced. Some tree species have fibrous roots and the rootlets have a tendency to concentrate at points of continuous water flow. This tendency is marked in case of several species of *Salix* (Willows). If such trees are planted along canal banks the root system will clog the pores and stop the movement of water. The soils along the canals show variability in physical and chemical

conditions. Trees matched to soil conditions, if planted insufficient numbers, will stop seepage in the long run. Suitable species can be chosen from *Dalbergia sissoo, Peltoferum ferruginum, Cassia siamea, Pongamia pinnata, Terminalia arjuna, Azadirachta indica, Haplophragma adenophyllum, Acacia auriculaeformis,Syzygium cumini, Salix tetrasperma, Poplar deltoides, Albizia lebbek* etc. The canal slopes should be planted with grasses and shrubs to prevent soil erosion. *Eulaliopsis binata, Cymlopogon jwarankusha, Adhatoda vasica* and *Cassia auriculata* will be good choice. A row of *Salix tetrosperma* planted through sets along the canal will help in reducing canal seepage as the fibrous root system will clog the pores. The field boundaries where conditions of waterlogging do not exist should be planted with Eucalypts. Due to their fast rate of growth the rise in water table could be controlled by planting adequate rows of trees. Such farms could utilise these trees for meeting their energy needs and simultaneously maintain their productivity for agricultural crops.

3. *Denuded Hill Slopes* : Hill slopes in Himalayas, Shiwaliks,Vindhyan tract, Satpura, Arawali,Nilgiris etc., all tell a sad tale of destruction of vegetation. Most of the top soil has been washed away. Trees are difficult to plant on these skeletal soils. These areas should first be planted with shrubs. Unfortunately the pressure of grazing and lopping isso heavy here that any tree or shrub that can be used as fodder has very little chance of success. Hardly shrubs that can grow on poor sites,can tolerate drought and are not lopped or fodder can ensure success. These shrubs should be nitrogen fixing. The shrubs that can be planted vegetatively will have better chances of success. *Rumex hestatus,Coraria nepalensis, Trema orientalis,Trema politaria, Woodfordia fruticosa,Rhus cotinus, Jasminum humile, Vitex negundu, Adhatoda vasica, Jatropha curcas, Crataegus crenulata* and *Osyris arborea* are some of the shrubs that can succeed. These$_3$ should be planted in pits of 30 cm^3. After the shrubs are established and some soil is built up trees could be planted subsequently.Soil conservation measures should be simultaneously adopted.

4. *Ravines* : Ravines occupy vast tracts of the country. Their peculiar problems are soil erosion, scarce moisture, low precipitation,fast runoff, uncontrolled grazing, high summer temperatures and severe frost on ravine bottoms. Afforestation should be combined with gully plugging. Planting should be carried out in two stages. In the first stage emphasis should be on gully plugging. Cutting that tape roots should be planted on the gully plugs. After the area has been under protection for sometime and movement of soil has been partly controlled through gully plugs trees, bamboos and grasses should be planted at suitable places. The flat tops should be planted with potted plants

of *Prosopis juliflora* and *Acacia nilotica* in pits of 60 cm^3 spaced 2 m apart.The ravine bottoms should be planted with *Syzygium cumini, Haplophragma adenophyllum, Dalbergia sissoo* and *Cassia siamea*. For gentle slopes *Acacia auriculata, Acacia nilotica, Pongamia pinnata, Pithecelobium dulce* and *Holoptelia integrifolia* will be suitable. Steeper slopes can be afforested with tufts of *Euliolopsis binata* and *Saccharum munja. Dendrocalamus sstrictus* will succeed on eastern and northern aspects. All ravines suffer from heavy grazing by goats. Nothing can be achieved unless their depredations are controlled. Aerial seedling in ravines has been a costly failure primarily for this reason. Nothing can be achieved by only seeding the area.

5. *Areas of Brackish Water* : Several states have underground brackish water. The main reason for brackish water is ecological. Almost total destruction of vegetation has caused this problem. There is otherwise no reason for brackish water to be found in the catchment of river Yamuna, a river of sweet potable water. The trend can be reversed by massive afforestation. If half of the areas could be brought under tree cover the problem of underground bracish water will disappear. Several trees and shrubs can grow well under irrigation with brackish water. Such species are *Cassia siamea, Cordia dichotome, Pongamia pinnata, Acacia nilotica, Prosopis juliflora, Cassia fistula, Mitrigyna parviflora, Haloptelea integrifolia, Cassia auriculata, Salvadora perssica, Capparis decidua etc.*

Management of Wasteland Afforestation.

Attempts were made in thepast inafforesting wastelands. Some of these attempts were quite successful. Allen Forest Kanpur (Present Zoological Garden) is a shinning example of what can be achieved.Protection of wastelands from grazing, lopping and illicit cutting is essential after the area is afforested. The forest once created should be a permanent feature of the landscape. The system of management should be such that the ground always remains covered. A multistoried forest of trees and bamboos wherein bamboos are harvested annually and top storey is preserved should be an ideal system for the future prosperity of the country.

SUMMARY

Half of the land mass of India is degraded. The productivity of this land is far below its potential. Wastelands are formed primarily by misuse or overuse. Large bovine population, far beyond the capacity of pasture lands, has been a major factor in the formation of such lands. Impeded drainage due to construction of embankments, roads and canals

are creating new wastelands. Usar, ravines, degraded hills, and water logged areas due to canal seepage, from the major part of degraded lands. With proper methodology of planting, correct choice of species and protection all degraded lands can be made productive. Afforestation of such lands will increase productivity of neighbouring agriculture lands by reducing salinity and improving water regime. Aerial seeding as a method of afforestation of such lands has been a costly failure.

Key words : Usar, Ravines, Rotations.

बंजर भूमि का वनीकरण

ए० एन० चतुर्वेदी

सारांश

भारतवर्ष की कुल भूमि का आधा भाग व्याह्लसित है। इसकी उत्पादकता इसकी क्षमता से बहुत कम है। भूमियाँ मुख्यतः गलत उपयोग या अति उपयोग से बंजर बनी है। ढोर-डंगरों की अधिक संख्या, जो गोचर क्षेत्रों की क्षमता से बहुत ज्यादा है, इस तरह भूमि के बंजर बनने का सबसे बड़ा कारण रही है। तटबंध, सड़क और नहर बनाने से जल निकास में पड़ी बाधाएँ नई-नई बंजर भूमि बना रही हैं। ऊसर, खड्ड, व्याह्लसित पहाड़ियां और नहरों के रिसाव के कारण बने जलमग्न क्षेत्र व्याह्लसित भूमियों का अधिकांश भाग हैं। वृक्षारोपन की उपयुक्त रीतियों, सही वृक्ष जाति के चुनाव और व्याह्लसित भूमियों की रक्षा करके इन सभी को उत्पादक बनाया जा सकता है। ऐसी भूमियों में वन लगाने से उनके पास की कृषि भूमियों की लवणता बढ़ेगी, जल स्थिति में सुधार होगा और फलस्वरूप उनकी उत्पादकता बढ़ेगी। ऐसी भूमियों में वन लगाने की विमान द्वारा बीज बोने की रीति बहुत खर्चीली विफलता सिद्ध हुई है।

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MANAGEMENT OF MAN-MADE FORESTS IN INDIA

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Two recent publications, a news paper article and a report have emphasised the role of forestry in the well-being of our country, as never before. Kamath (1985) in his article states that, "such of those environmentalists who were around a generation ago, called themselves intellectuals, were laughing at Dr. K.M. Munshi who had proposed a wholesome environmental regeneration programme in the form of *Vanamahotsava* for the improvementt of our forest cover. Munshi was dismissed as a reactionary with quaint ideas of growing more trees. It now seems that the scholar-environmentalist was a generation ahead of his times. If *Vanamahotsava* was relevant in 1952, it has become even more relevant now with our forest cover down to a dangerous 10 per cent". The publication by Centre for Science and Environment (Editorial, 1985) of *the State of India's Environment 1984-85.* The Second Citizen's report underscores with compelling force how dangerously close the country has come to the brink of an ecological disaster. The National Forest Policy of 1952 enjoined on professional foresters to "save the people from their imprudence". What actually happened after the Independance is there to see for ourselves. There may be many reasons for the situation that is brought about. One and quite important, among them was the lack of political will and hence shortage of funds.

Today Forestry in India has all the support that Indian foresters hoped for. Since last decade forestry and tree culture is talked about, people are becoming more and more aware of the relationship between trees and well-being of everything living on this planet, including man himself. The Prime Minister Shri Rajive Gandhi has given concrete shape to the expectations of the foresters by creating a separate department at the Centre for Forests and Wild Life, justifiably linked with the department of environment. Financial allocations have been increasing from last Five Year Plan. Forestry has risen from twelfth position on the New 20 Point Programme to second position on the list of action plan put before the Nation by the

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Prime Minister.Increased attention to forestry reciprocally entails increased responsibilities on the managers of the forests.

Let us see what is expected of these forest managers before we proceed to put forth the management of man-made forests in the country. According to Davis (1960) the professional forester, needs amongst other things, to be an alert, flexible administrator combining the all round resourcefulness of a successful businessman. Jhonston, *et al*, (1967) cautioned the professional foresters that the mankind is neither unhurried nor predictable and if the forests are to serve him, its management has to move with the times. Osmaston (1968) defines the fundamental purpose of forestry as to secure the greatest continued value from the land allotted to forestry. Brasnett (1966) underlines the primary object of good (forest) management as the provision of the maximum benefit to the greatest number of people for all times. Duer *et al* (1979) maintain that, "the shifting aims and context of forest resources management are the functions of what people want from the forest. Therefore, people provide the direction, forest provides the means". Forest management like any other management, occurs, not in isolation, but in a given set of conditions which go to make its environment (Maslekar, 1983). All these quotes sum up aptly the objectives of forest management.

Man-made forestry, suddenly found its supporters with the publication of the Interim Report of the National Commission on Agriculture (NCA) - Man-made Forestry, in 1972, because it brought into sharp focus the forestry situation in the country and the tremendous gap between the supply and demand of forest products. Man-made forestry was not unknown to the professional foresters. Working Plans, the basic document in management of conventional forestry, did prescribe employment of artificial regeneration to supplement forest recoupment efforts after harvest of standing crop. The difference in Working Plan Prescriptions and modern man-made forestry, is firstly the extent of operation. Secondly economics which was implied in Working Plan activities became explicit and fundamental in operation of extensive man-made forestry. Among other things, man-made forestry efforts were to be well-tested and economically viable projects.

Much water has flown under the bridge during the last decade. Forest Development Corporations (FDC) were established in many States to handle intensive man-made forestry "projects". Much good work has been done and almost one million hectares have come under the man-made forestry in the country since then.

Man-made forestry also got a significant boost with the launching in early eighties of social forestry projects with international aid in different States. Some individuals like Shri Kalidas Bhai Patel of Gujarat made noteworthy and pioneering contributions towards farm forestry (or better denoted as forest farming). Urban forestry has become a popular activity in Metropolitan cities like Bombay, Ahmedabad, New Delhi and Calcutta, thanks to the voluntary organisaztions like Friends of Trees. Industries, facing the reality of reduced supplies of their forest raw-materials have been trying to acquire forest lands (other lands may not be available so cheaply and easily) on lease to raise forest crops. State Governments on their part have also realised the enormity of the task of clothing back degraded forest areas and are proposing nominal rents and long term leases to individuals, institutes and organisations for doing the job at their costs. Final harvest is proposed to be shared by the Government and the lessee.

Concern was expressed about the present land-use under various sectors and the imbalanced nature of relationship between them. A society for Waste-land Development was found in 1982. The establishment of Waste-land Development Board at the Centre recently with an objective of afforesting 5 million hectares annually culminated the expression of concern for the grave situation. All in all, it can be said that the people at all levels of the society have realised the importance of trees and forest and have decided to act upon, and act on war footing.

One may pause and question the need for man-made forerstry here. The NCA, has made it amply clear that the country's forests are understocked, have slow growth and low yield as compared to forests elsewhere. They are, therefore, not capable of meeting even a quarter of the demand for timber and firewood. It has to be realised that a primevial society such as tribals depend largely on forest for their livelihood. At the other end of the scale the developed countries need more forests and forest products, even if they are only intangibles, for their way of life. Existing forests are therefore inadequate to deliver the goods. It is also true that forest lands under the State control are not likely to increase in extent in near future. There is, therefore, no alternative left but to go for intensive, high yielding, short duration man-made forest crops both on forest and non-forerst and private lands wherever possible. From this need emerged the concept of two-pronged attack of production forestry and social forestry.

Discussion so far, also provides the indications of the kinds and locations of man-made forests of future. They need to be noted before their management is considered.

(1) Existing natural forests will mostly have the role of protection of gene pools of both flora and fauna. They will help in maintaining local water table and environment. Such forests will necessarily be far situated, away from the denser population centres. They will also be providing recreation and tourism.

(2) Forests nearer the habitations will vanish inspite of protective measures, because of the linkage between firewood and economic necessity of large number of landless labourers migrating to such townships and cities. They also fulfil the energy needs of many in such towns and cities, who do not have other sources like coal or electricity.

(3) Man-made forests will logically be located nearer elightened population centres. Gujarat provides a typical example of this phenomenon. Their location is also linked up with market.

(4) Such man-made forests will have different ownership patterns and hence will have different management prescriptions.

(a) Forest plantations on forest lands raised by Forest Department and Forest Development Corporations.

(b) Forest crops raised by social forestry wing/ Department on community lands and other open spaces like road sides, canal sides, railway tracks etc.

(c) Forest crops raised by Institutions/social organisations and other Government Departments on their lands e.g. schools, ashrams, defence establishments.

(d) Forest crops raised by individuals and cooperative ventures purely from commercial angle.

(e) Forest crops raised by individuals 'settled' on degraded forest lands/Adivasi lands with Government help.

(f) Urban forestry.

(g) Captive plantations : Forest crops raised for raw materials by industries.

Categories (b) to (e) have very recent origin, not more than 4-5 years old in most of the States. As regards community lands are concerned the crops raised on them are better managed by Panchayats. Government should have the least concern about such forest crops. Crops raised by institutions, social organisations or other departments should be managed by them. Category (d) is the most important catalytic agent in the popularisation of forest-farming on commercial scale. The individuals/cooperative societies should manage them. In all these categories professional foresters could play the role of consultants and advisors. Category (f) is an urban activity where forest crops or tree groups are raised for aesthetics, recreation, as the "lungs" of city life, as well as for education. They will be important link between city people and forests. These urban forests must be managed by Municipalities/Corporations or by assigning them to big industrial houses, as in Bombay. This will be mostly a parks and gardens activity. The so called captive plantations of industries should be managed either by industries themselves or by a joint sector management of the industry and the Government forest department or FDC. As far as possible Government should create facilities and give encouragement for such forestry activities. But Government may not involve itself in its management. Category (b) is expected to be carried out by Panchayats themselves after the current social forestry "Projects" come to an end. Social forestry wings or departments should return back into the Forest Department fold, at the latest by say, the Seventh Five Year Plan, when their role as change agents would have been over.

Managing the Government-owned man-made forests

The discussion in this paper is purposefully limited to the man-made forests. Man-made forestry has been at least now ten years old. It is a pathfinder for others. Experience gained in the last decade will be valuable in modifying the approach, avoiding pitfalls, avoiding wastes and streamlining the activities. Some important lessons emerging are :

(1) FDCs were established to avail the institutional finance. Autonomy was the basic assumption of the concept. The experience shows that FDCs did not avail the institutional finance on scale that was expected. One could as well say now that such finance is not needed. Institutional financing, at a high rate of 12 1/2% has affected profitability of the venture and made the servicing of the loans difficult. The corporate working has attracted Central Income Tax wherever profits were made. Rethinking is, therefore, needed in financing Government-owned man-made forestry projects.

(2) Primary function of FDCs, of raising plantations successfully, was not always in focus and diverse activities were attempted. Welfare activities, started to woo the labourers have now become liabililties. Labour remains largely insatiated.

(3) Physical targets were duly achieved. Upkeep and after care suffered as years passed. Crops were not tended in time. By and large 30-40% plantations failed, due to various reasons. This may not be unusual in departmental efforts but is not expected from a commercial venture.

(4) Personnel management became difficult with direct recruitment of staff in FDCs. Relations between deputationist staff from the forest department and FDC

employees became strained.

(5) Autonomy remained mostly on paper. FDCs. hardly shed "departmental" approach.

(6) Large scale plantations of so called "important" species resulted in "monocultures" which are now resented by the "environmentalists".

These are some important experiences gained in the last decade. These need to be considered in planning man-made forests of future. Author suggests following shape of things to come:

(1) There wll be total ban on felling of trees in the existing forests, even if for replanting.

(2) Forests of single species are already banned by a recent circular of the Centre. Mixed plantations will be attempted. Welfare activities, started to woo the labourers have now become liabililties. Labour remains largely insatiated.

(3) There will be tremendous pressure, particularly for fir wood, on existing forests and man-made forests of last decade due to increasing population, shortage of wood and lack of immediate alternatives. The efforts in non-forest lands will not be yielding for one coming decade. Protection of forest will be very important function.

(4) Accurate knowledge of soils, terrain, precipitation, suitable species, growth patterns and yield estimates will be apriori needed. This has been the principle lacuna of past effort so far. Waiting period of less than ten years for harvest will be preferred.

(5) Planting, particularly on degraded forest and wasteland, will be a costly activity, and therefore success needs to be ensured. Accountability of the managers will be more severe. Author estimates Rs. 10,000/- ha. for five years. With a modest target on one million ha. per year, we will need Rs. 1000 crores outlay for Five Years activity.

(6) Regional and river-basin level planning will be demanded, instead of planting in existing forest areas and accessible sites.

(7) Foresters will have to show results, which people expect from forestry practice. People will decide and direct what to do and where. Success in private sector will bring in more competitiveness.

(8) These man-made forestry projects will be socially desirable. Therefore, they will have to pass social benefit/cost tests even if economic analysis, rejects them.

(9) These man-made forestry projects will be time-bound programmes to be managed like agriculture farms. The managers who will manage them should devote their full time to them

without any other responsibilities. For this purpose a unit of management should have an annual planting target of maximum 500 ha with a Deputy Conservator of Forests in charge.

(10) A Dy. C.F. will be assisted by one ACF and 5 R.F.Os., 4 for planting job in its entirety, and one for nursery. No other regular staff will be employed. Rest of the staff will be work-charged staff, limited to the life of the project.

(11) It is preferable to pay higher wages to supplimenting wages with food and other commodities. Labour welfare should, however, be an integral part of the project.

12. No permanent structures should be allowed in such projects, except for damming nallas and for storing water.

13. Mesta or cotton or improved varieties of grass could be grown along with main crop in the first year only. Bamboos could be under planted only after 5th year of the plantation.

14. Irrigation is a very costly input, and involves large capital expenditure. It may be done where possible. But emphasis should be more on good soil working, soil conservation and water management measures.

15. Instead of planting single chosen species, a combination of timber-firewood-fodder/food species be adopted. Not more than four species including bamboos be planted at a place. Fruit trees like mango should also be planted, at a rate of 20 trees per hdectare in each planting site.

16. Rigid protectioin against grazing, fire and pests, will be ensured.

One could expect to make India green with these guide lines in view and emphasis on ensuring at least 80% success of every hectare planted. Plants should not only survive but must conform to the expected growth pattern.

SUMMARY

Natural forests of India have been under pressure particularly since the Independence. Recent studies indicate that the country may not have even 10% of the land under forests. The widening gap between supply and demand of the forest products can onbly be met through undertaking extensive as well as intensive man-made plantation efforts. Almost a million hectares have come under such plantation in the last decade, particularly after the publication of the "Interim Report of the National Commission on Agriculture Man-made Forestry" in 1972 and establishment of Forest Development Corporations in different States.

The plantations created so far have given very valuable experience and one is now able to plan in a better manner for the future. This article indicates the salient experiences gained and makes suitable suggestions for the future management of man-made forests in the country.

भारत के मानवनिर्मित वनों का प्रबन्ध

ए० आर० मासलेकर

सारांश

भारत के प्राकृतिक वनों पर, विशेषकर स्वतन्त्रता मिलने के पश्चात् बहुत अधिक दबाव पड़ता रहा है। विगत अध्ययनों से संकेत मिलते हैं कि 10% भूमि पर भी कदाचित् वन नहीं हैं। वनोपजों की मांग और प्रदाय के दरम्यान निरन्तर बढ़ती खाई विस्तृत एवं सघन, दोनों प्रकार के मानवनिर्मित रोपवन लगाने के प्रयत्नों द्वारा ही भरी जा सकती है। पिछले दशक में विशेषकर राष्ट्रीय कृषि आयोग-मानवनिर्मित वन की अन्तरिम रिपोर्ट के 1972 में छपने तथा विभिन्न राज्यों में वन विकास निगमों की स्थापना हो जाने के बाद लगभग दस लाख हैक्टेयर क्षेत्र में ऐसा रोपण कार्य किया जा चुका है।

अब तक लगाए गए रोपवनों से बहुत मूल्यवान अनुभव प्राप्त हुआ है और अब भविष्य के लिए और अच्छी तरह से योजना बनाई जा सकती है। प्रस्तुत अभिपत्र में अब तक मिले कुछ मुख्य अनुभव बताए गए हैं और देश में मानवनिर्मित वनों का भविष्य में प्रबन्ध करने के लिए कुछ उपयुक्त सुझाव दिए गए हैं।

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CONIFERS OF INDIA AND THEIR WILD GENE RESOURCES IN RELATION TO TREE BREEDING

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Introduction

Conifers occupy about 3.3% of the total forest area in India mostly in Himalayas but they meet 25% of wood needs of the country. Indian conifers provide raw material for the manufacture of high quality fibre-rich wood-pulp, specific timbers, and superior terpenes and rosins for many oleo-resin based industries situated in the plains. They play an environmental role of water and soil conservation in the water chatchment areas and ridges of the Himalayan rivers. The conifers species of India and their forest gene resources are discussed in this account for use of foresters and tree breeders. It is based on field observations carried out by me in the Himalayas during the year 1952 to 1984 and on information published by others (Mainly Brandis 1911, Champion & Seth 1986, Raizada & Sahni 1960, Troup 1921, Florin 1967 and others.

Distribution

Conifer forests are distributed in India within a very narrow 3,200 kms long belt which runs West to East along the entire length of the Himalayas. About 11 genera and 24 species are native to India of which only a very small number form extensive forests. The main forest forming genera are *Pinus, Abies, Picea, Cedrus* and to a lesser extent *Tsuga, Cupressuss* and *Juniperus*. *Pinus, Abies, Picea, Cupressus* and *Juniperus* are widespread but *Cedrus* grows widely only in North-western and *Tsuga* in the Eastern Himalayas. There are a few species like *Pinus wallichiana* (Dogra 1972) which are very widely distributed along the entire length of the Himalayas and they thus show more genetic diversity than the other conifer species. Most species, however, are restricted within specific latitudinal and altitudinal ranges. Conifers are bi-hemispherical in distribution (Florin 1967). *Podocarpus* of the Southern-hemisphere however penetrates into India with 2 species of which one, i.e., *P: uallichianus*, is indigenous to the Indian peninsula.

The Himalayas are the highest and largest mountains of the world. They show great climatic and site diversity even within very narrow geographiczones.The monsoon-rains fall the heaviest in the Eastern Himalayas. They are gradiently weakened as one proceeds from East to West. On the outer aspect of entire Himalayan ranges the monsoon rains are heavy but from South to North in inner ranges they weaken. They are often absent in the inner areas which lie behind the main Himalayan ridges.

Specific altitudinal forest ecosystems constituted of definite combinbation of tree species are arranged on altitudinal clines. These are a characteristic feature of both the outer moist as well as the inner dry regions respectively.

There is a cledar demarcation between two groups of conifer species in the Himalayas : one of drier Western and the other of wet Eastern region. In Himalayas the gradient is exceptionally steep and along it the climate-change is great. The vertical zonation of each species is therefore characteristically narrow. The vertical arrangement of species in altitudinal zones of the southern and northern mountain aspects also differ from each other.

Intraspecific genetic variability is present particularly in species which are most widely distributed in the Himalayas, along the whole length as well as within broad altitudinal zones. Each species covers vast areas and is differentiated into many genetically different provenances. Each provenances is adapted locally to distinct climatic and altitudinal zone and it has a distinct latitudinal range.

The conifers including taxads have 7 families of which 5 are present in India. Pinaceae has 6 and Cupressaceae 2 genera. Podocarpaceae, Taxaceae and Cephalotaxaceae are all represented by only one genus each. Species belonging to Taxodiaceae and Araucariaceae donot grow wild in India.

Pinaceae

Four genera of pinaceae dominate the major forest regions of the Himalayas i.e., *Pinus*, *Abies*, *Picea* and *Cedrus*. In Eastern Himalayas *Tsuga* also forms fairly large forests but *Larix* is distributed only in a limited region. Pinaceae has 3 subfamilies of which Abietoideae has 6 Laricoideae 3, and Pinoideae 1-2 genera. All 3 subfamilies are represented in India : Abietoideae has 3 genera, namely, *Abies*, *Picea* and *Tsuga* Laricoideae 2, *Larix* and *Cedrus* and Pinoideae only one *Pinus*.

Abies is classified into 2 subgenera,15 sections, 39 species, 27 varieties and,9 hybrids (Liu 1971). From India Bor(1953) and Raizada & Sahni (1960) describe 4; Brandis (1911) and Mehra & Jain (1976) 3; and, Dallimore & Jackson (1966) two species. From North- western Himalayas alone Gaussen (1964) describes 4 species. It is however two species that form major forests i.e. *Abies pindrow* in the Western and *Abies spectabilis* in both the Western and the Eastern Himalayas.

A. spectabilis in the Western Himalayas grows in altitudes higher than, and above the *A. pindrow* forests. Liu (1971) recognizes 3 species in the Himalayas i.e., *A. pindrow*, *A. spectabilis* and *A. delavavi*, *A. delavavi* is however a fir of Central and S.W. China. It crosses the Chinese border into India to form a restricted forest patch on the Balipara Frontier tract. It is therefore safer for the present to follow Parker (1940) and Dallimore & Jackson (1966) and recognize only 2 main Indian species : *A. spectabilis* and *A. pindrow* which Liu (1971) places in a single section. *Pindrau* Mayr : emend. Liu of the subgenus *Abies*.

Abies pindrow (Royle) Spach is distributed widely in N.W. Himalayas from Afghanistan to Nepal between 2,300-3,750 m altitudes. The species does not extend East of Kumaon (Bor 1953). In the Western Himalayas *A. pindrow* has a more wider distribution than *A. spectabilis* because it is well adapted to grow at a lower altitudinal range and is thus able to cover a wider area (Liu 1971). The low level fir attains large dimensions in Himalayas with heights up to 36 m and girths of 9 m. The wood is soft suitable for matches and paper pulp. Attacked by the fungus the wood gives rise to brown wood as in *Picea smithiana*.

Abies spectabilis (D. Don) Spach : The species is distributed in the upper Himalayas from Afghanistan to Bhutan between 2,750-3,900 m altitudes. It forms extensive pure fir forests in Eastern Himalayas above 3,100 m elevations where it grows in very humid regions. In Western Himalayas it occurs only at higher elevations above the *A. pindrow* forests spreading right up to the tree limit in open forests or in isolated groups on rocky elevations. *A. spectabilis*, *Betula utilis* Don and junipers are the last tree species at the tree line where they become stunted.

The shade loving, moist *Abies* forests growing in dense mists during monsoons have large,dense, narrowly pyramidal trees growing on cool moister slopes of northerly aspects of Himalayas. These are highly resistent to low temperatures. The two fir species along with spruces are well adapted to grow in heavy snow fall regions and their forests cover most of the timber line of water catchment ridges of Himalayas. On the termination of winter the snow in lower distributional limits stays beneath these forests for several months melting gradually during the year.

Picea

Picea has 3 groups : *Eupicea*, *Casicta* and *Omorika*. Only 2 are represented in India : *Eupicea* by *P. smithiana* of Western; and *Omorika* by *P. spinulosa* of Eastern Himalayas.

Picea smithiana (Wall.) Boiss. is distributed in Western Himalayas forming extensive forests over wide stretches of the country from Afghanistan to Kamaon between 2,130-3,350 m altitude.

It has very large trees in N.W. Himalayas with heights up to 66 m and girths up to 6 m wood is soft to moderately hard. Old trees develop brown wood in the lower part of the stem the formation of which is caused by the fungus. It grows in wet shady cold regions and forms pure or mixed forests which can withstand much exposure to winds. Trees have pendulous branches and they resist snow break *P. smithiana* therefore often forms forests with *Abies Pindrow* because both are adapted to grow in snow bound cold shady sites.

Picea soinulosa (Griff.) Henry. is distributed in Sikkim, Lachen valley, Chumbi valley of Tibet, and Bhutan from where it extends eastwards to Mishmi hills and Burma at 2,600-3,350 m elevation. In Sikkim, it usually grows mixed with *Tsuga dumosa*, *A.spectabilis* and *Larix griffithii*. The species has tall trees which are well over 60 m in height. Trees of immense heights, have been found in Lachen valley (Dallimore & Jackson 1966).

Tsuga

Tsuga consists of about 10 species growing in temperate cold regions. The genus is divided into two sections *Hesperopeuce* Englemann and *Micropeuce* (Spach) Schneider.

Tsuga dumosa (D. Don) Eichler forests of large trees occur only in Central and Eastern Himalayas. Abundant in inner ranges the species is distributed from Kumaon to Bhutan, Mishmi, N. Burma to East, between 2,440-3,050 m altitudes. Towards west pure *T. dumosa* forests occur only in some blocks in *E. Almora*. The species generally grows in East mixed with *Picea spinulosa*, *Rhododendron* and *Abies* species. Trees up to 56 m in height and 6 m girth are recorded (Troup 1921). Wood is soft and white.

Laricoideae

Larix has about 10 species which form extensive forests in temperate cold regions. In India, large forests of *Larix* are absent. Only one species, *Larix griffithii is* found and this too has only a limited distribution in the Eastern Himalayas.

Larix griffithii Hooker f., forms open deciduous forests of poor height in deep valleys mostly on dry rocky moraines and on grassy slopes between 2,400-3,650 m in Eastern Himalaya. It is limited in distribution from Eastern Nepal to Sikkim,in Chumbi valley (Tibet), Bhutan and Mishmi country. Some times the species grow mixed with *Pinus wallichiana* or forms pure patchy forests above it. It is sometimes associated with *Abies spectabilis*,*Picea spinulosa* and *Tsuga dumosa*. Trees up to 20 m in height are recorded as common.

Cedrus has 4 species that show a discontinuous distribution in N.Africa and Asia. *C. libani* is most numerous in the Taurus mountains, *C. atlantica* in North African mountains, *C. brevifolia* in *Cyprus*, and *C. deodara* in the Himalayas. The distinction between the 4 species is minor. Some authors consider all four to be geographical sub-species or varieties of a single species *C. libani* (Dallimore & Jackson 1966).

Cedrus deodara (Roxb.) D. Don, a very large tree is distributed through out the Western Himalayas from Afghanistan to Garhwal at 1,200-3,300 m altitudes. *Cedrus* does not grow, east of river Alaknanda in Garhwal. It has a wide altitudinal and latitudinal distribution, in both inner dry, and outer wet monsoon zones of Himalayas. It frequently forms pure or mixed forests mostly with *Pinus wallichiana Picea smithiana, Quercus incana* and other broad leaved species. The most important associate of *C. deodara* is *Pinus wallichiana*. Pure *Cedrus* forests are common in deodar zone but especially in inner dry valleys. The Himalayan *Cedrus* attains huge dimensions and is perhaps one of the largest and most important timber trees of N.W. Himalayas attaining heights up to 80 m and girths up to 12 m. It yields the most durable conifer wood.

Pinoideae

Pinus the only genus of pinoideae is divided into two subgenera : *Haploxylon* the soft pines, and *Diploxylon*, the pitch or hard pines (Shaw 1914,1924). Both are represented in India with 2 species of each. Critchfield and Little (1966) classify the pines; into 3 subgenera, 5 sections, 15 subsections and 94 species. Only 4 species grow in India,i.e., *P. roxburghii*, *P.kesiya*, *P. wallichiana* and *P. gerardiana*. The first two, belong to the subgenus *Strobus* Lemm. (Critchfield & Little 1966) or to *Haploxylon* the soft or white pine group (Shaw 1914,1924): and the last two, to the subgenus *Pinus* Critchfield & Little 1966) or to *Diploxylon* the hard pine group (after Duffield 1952).

P. wallichiana A.B. Jacks is widely distributed along the entire length of the temperate Himalayas, in latitudes 25°N- 36°N and longitudes 68°E-100°E. Its altitudinal range 1,200-3,800 m, or more is far greater than that of any other Himalayan conifer. In the Northwest abundantblue pine forests grow in Kashmir, Himachal Pradesh, and Uttar Pradesh. They are absent in some parts of Kumaon,but reappear again in Nepal.In the Eastern Himalayas natural forests of blue pine are absent in Sikkim. They have however been reported in Chumbi valley lying in Tibet across the Sikkim border *P. wallichiana* is abundant in Bhutan. In East,it is distributed in small scattered out-lier patches in Assam and in regions on the North and East of Brahmaputra extending right upto N. Burma and Yunnan in China where its distribution overlaps that of *P. tabulaeformis* Carr. and *P. armandi* Franch. *P. wallichiana* is the second most important timber producing conifer next to *Cedrus deodara* in the N.W. Himalayas. The trees reach large dimensions with heights up to 55 m and girths up to 6 m (Troup 1921). Wood is moderately hard, heartwood is pink and of good quality only slightly inferior to wood of *C. deodara*.

Pinus bhutanica Grierson, Long & Page species *nova* a recently discovered new species of 5-needled pine related to *P. wallichiana* A.B. - Jack and *P. armandi* Franch, is described by Grierson *et al.* (1980) from Eastern Bhutan and from the neighbouring Arunachal Pradesh, State in India. It is fertile and has distinctive features of its own *P. bhutanica* is considered to be a relict species containing attributes of both, *P. wallichiana, P. armandi* and also characters which have evolved independently. *P. bhutanica* is distinctly eastern in distribution and local to Bhutan. It grows in a 1,750-2,400 m altitudinal range which partly overlaps the range of *P. roxburghii* below and that of *P. wallichiana* above. It differs from these 2 species in showing a marked preference for growth in moist mixed broad leaved forests in Eastern Bhutan.

P. roxburghii Sarg. forests grow, in latitudes 26°N-36°N and longitudes 71°E-93°E. Confined to the sub-tropical and warm temperate monsoon belt, the species is distributed between 450 to 2,300 m altitudes in the Siwaliks and in the main Himalayan river valleys, from Kashmir to Bhutan. It occupies a considerable area of the country growing on dry, infertile and poor soil regions where other trees fail to grow. This species is the principal resin producing pine of India. Sapwood is white but heartwood is light reddish brown, moderately hard but coarse due to the presence of resin ducts. It is fire resistant with bark up to 8 cms in thickness exfoliating in rough, thick elongated plates. Under favourable conditions *P. roxburghii* trees form straight cylindrical boles and attain large dimensions up to 60 m in height and 5 m girth.

P. kesiya Royle ex Gord. grows in latitudes 11°N-30°N and longitudes 90°E-125°E. It is widely distributed between 750 to 2,000 m in Khasi, Manipur and Naga hills in India from where it extends between altitudes 900 to 3,000 m to the valleys of Zayul n South-eastern Tibet, South-western Yunnan, highlands of Southern Vietnam and to the mountains of Northern Luzon in the Philippines Islands. The distributional limit of the species, in China and in South-eastern Asia is however uncertain. It however oerlaps the distribution of *p. tabulaeformis.* A large tree up to over 34 m in height and 3 m in girth.Wood moderately hard, pale brown to red and very resinous.

P. gerardiana Wall. prized for its edible seed, occurs within the latitudes 30°N-37°N and longitudes 66°E-80°E. *P. gerardiana* forests, in India, are found in the dry, inner Kinnaur and Pangi valleys of rivers Sutlej and Chenab in Himachal Pradesh and extends westwards to Kishtwar, Astor in Kashmir,Chitral, Afghanistan and Northern Baluchistan between the altitudes of 1,600 and 3,600 m. The pure and mixed forests of Kinnaur in the Upper Sutlej valley have been surveyed in detail, by Dogra (1964). The tree is valued for its edible seed and hard, tough resinous wood. Trees up to 26 m in height and 5 m girth are recorded (Troup 1921).

Cupressaceae

Cupressaceae has 22 genera. About half of these belong to the Northern hemisphere and the other half to the Southern. These are placed in two sub-families : the Northern Cupressaoideae and the Southern Callitroideae. Only Cupressoideae with two genera, *Cupressus* and *Juniperus*, are represented in India.

Cupressus has about 20 species Only one *C. torulosa* grows in the Himalayas the other *C. cashmeriana* is unknown in the wild state (Dallimore and Jackson 1966).

Cupressus torulosa D.Don, is a large tree grows in open patches but it rarely forms extensive forest-blocks. It grows in wide variations of climate. The open forest patches occur at 1,800-2,800 m elevations in the outer Himalayas from Himachal Pradesh to Nepal where they mostly grow on limestone rocks. Bor (1953) records the species from Assam *C. torulosa* is fairly common in W.Szechwan, China, between 1,800-2,400 m elevation, in the upper arid regions of the river Tung. The timber is durable moderately hard and of excellent quality with light brown fragrant heartwood.Trees 50 m high and 8 m in girth have been measured.

Juniperus with about 70 species is the most advanced and the largest genus in Cupressaceae and the third largest amongst living conifers. It has two sections of which *Oxycedrus* has 10; *Sabina* about 60 species (Florin 1967). Species from both sections are represented in India.

In *Oxycedrus*, 3 species i.e. *J. communis*, *J.squamata* and *J. recurva*, grow in India.

J. communis L., shows a world wide distribution.In India, the species grows in Western Himalayas between 1,700-4,300 m altitudes and its distribution extends eastwards to Garhwal and Kumaon. It grows as a small tree or a shrub often procumbent forming prostrate matlike growths at high elevations.

J. squamata Buch.-Ham., is a prostrate shrub distributed in the N.W. Himalayas at 2,400-4,300 m altitude. It grows in the alpine regions above the tree limit often with *J. communis* forming dense, waist-high thickets.

J. recurva Buch.-Ham., grows as a shrub or a small 9-12 m high tree. I observed rare trees up to 15 m in height in 1962 in Sikkim. Distributed widely in Eastern Himalayas between 1,700-4,600 m altitude it occurs in Sikkim and Bhutan, from where its distribution extends into East Upper Burma and China.

In the *Sabina* sections, there are two Indian junipers : *J.macropoda* and *J. wallichiana*.

J. macropoda Boiss. is a shrub

or a 12-15 m high tree. It is a small or medium sized tree forming forests in cold arid desert in which trees 2-3 m in girth are common but rarespecimens up to 11 m in girth are reported from Lahul (Bor 1953) and rare 20-34 m high trees by Troup (1921). The species forms extensive forest in its region: Iran, Afghanistan and Baluchistan. In India, it is found at 1,500-4,300 m altitudes only in the inner arid ranges of the N.W. Himalayas from where it moves as far down as Kumaon. It forms gregarious open-forest patches or grows as scattered trees on dry rocky sites with scanty rainfall in cold arid deserts of Lahul valley in Himachal Pradesh. The tree is hardy to drought, frost and low temperatures. It is wind firm becauseof strong spreading root system. The wood is hard and fragrant. The bole is often branched at base. It is often crooked and gnarled and attacked by the parasite *Arceuthobium oxycedri* M. Bieb. Some consider this species to be identical with J. *excelsa* M. Bieb. Dallimore & Jackson (1966) state that this species connects the Eastern Asiatic J. *chinensis* with the Western one J. *excelsa*. Mehra & Jain (1976) however recognize two distinct juniper tree species in N.W. Himalayas, namely J. *macropoda* Boiss. and J. *excelsa* Bieb.

J. *wallichiana* Hook. f. a shrub or small tree is distributed at 2,800-4,600 m altitude from Indus to Bhutan and Yunnan. Open tree stands 18 m in height grow in inner dry mountains in Sikkim and N.E. Frontier. They are similar to the forests of J. *macropoda* of inner N.W. Himalayas.In Western Himalayas J. *wallichiana* grows as a procumbent shrub in gregarious dense patches which cover large areas and dry sites above the tree-limit.

Podocarpaceae

Podocarpaceae with 7 genera and about 150 species is the largest conifer family of Southern Hemisphere. Only *Podocarpus* with 2 species are found in India.

Podocarpus, with about 110 species is the largest genus in the family Podocarpaceae and in all living conifers. It is divided into 8 sections, the largest of which is *Podocarpus* which is again reclassified into several sub-sections. The two *Podocarpus* species, P. *neriifolius*, and P. *wallichianus*, found in India belong to the *Podocarpus* and *Naegia* sections respectively.

The section *Podocarpus* (Eupodocarpus) is the largest of the 8 sections, with approximately 70 species re-classified into 6 sub-sections (A-F). Only P. *neriifolius of* sub section B is found in India. Sub-section B of section *Podocarpus* has 30 species with a wide and continuous distribution in the Western Pacific but it is absent from its Eastern part. It is distributed from the South-western and Eastern Australia, Tassmania, New Calendonia, New Hebrides, Fiji, Malaysia, New Guinea to Sumatra,Andaman Islands and South-eastern Asia which includess Eastern parts of India, where it occurs between 150-2,300 m altitudes.

Podocarpus neriifolius D. Don (Podocarpus) has variable sized trees 12-40 min height.In Himalayas it sometimes become a very large tree giving a high class timber. The species is distributed from 650-1,300 m altitude in subtropical mixed evergreen forests in S.E. Asia, where it extends fromEastern Himalayas Sikkim eastward to the forestsof Assam,Burma,China, Malaya, Andaman Island, Japan, East Indies as far as Fiji. It is stated to be absent from Nepal. In Andamans it is common in evergreen forests of higher hills. *P. neriifolius* has the widest distribution in the genus stretching from mountains of Nepal, east into China and Philippines into S.E. Asia and Malaysia.

Naegia, with its 7 species grows right from sea level to 2,200 m altitudes and is distributed from Papus (New Guinea) to Malaysia, Philippines,Borneo, Sumatra to Southern Nicobar Island and Burma. *Naegia* is also scattered in regions lying North of Malaysia,i.e.,in South-western and North-eastern India peninsular,Thailand, Indo-China, S.E. China,Taiwan and Japan.

Podocarpus wallichianus C.presl. (*Naegia*), the only conifer indigenous to the Indian peninsula with trees upto 24 m in height, is distributed at 900-1,500 m altitudes in Khasia,Assam and Burma and in Western Ghats from Nilgiri Southwards. The species although reported from Greater Nicobar Island is absent from the adjoining Andamans (Raizada & Sahni 1960).The wood is grey, aromatic and moderately hard (Bor 1953).

Taxaceae

Taxaceae consists of 5 genera of which, only one *Taxus* with a single species, *T. baccata*, is widely distributed in the Himalayas. The Indian species range forms a part of its larger Eurasian distribution. From N.E. Afghanistan it spreads over the Himalayas to Khasia, Northern Burma and Southern China. Seed dispersal of *Taxus* by birds accounts for its large distribution.

Taxus baccata L. is a 6-25 m high shrub or a tree distributed above 1,800 m altitude in the Himalayas and in the hills of Khasi-Jaintia, Naga, Manipur and Burma. It grows mixed in other evergreen or conifer forests and often as an underwood.As a tree *T. baccata* sometimes attains a great age and very large proportions in the Himalayas. The wood is hard close and even grained tough and elastic. Very large trees, though not common attain great heights and girths. Trees up to 34 m height and 5 m girth have been recorded. Tree growth is slow. *Taxus* is usually found growing in association with *Quercus* , *Cedrus*, *Picea* and *Abies* in Western Himalayas and in Eastern with *Abies*, *Tsuga*, *Picea*,*Rhododendron* and *Quercus* species.

Cephalotaxaceae

Only one living genus *Cephalotaxus* with about 6 species is distributed from Eastern Himalayas to Assam, Burma, Thailand, Indo-China China, Southern Vietnam, Taiwan Japan and Korea. Two species, *C. mannii* and *C. griffithii* grow in India as small trees which are distributed in the upper evergreen forests of Khasi and Naga hills in Assam and in parts of Eastern Himalayas and Upper Burma. *Cephalotaxus mannii* Hook. is distributed from 1,370-2,590 m in Khasi, Jaintia and Naga hills and *Cephalotaxus griffithii* Hook. from 1,520-1,820 m in N.E. Frontier tract, Naga Manipur, Mishmi hills, and Burma.

Natural intraspecific variability in widely distributed species

Genetic variation found in a widely distributed tree species is associated with geographically different regions and climates to which the species and provenances are adapted. The Himalayas have numerous climatic regions which differ outstandingly from each other. The natural ranges of several conifer species overlap many climatically diverse regions and they therefore show much genetic diversity.

Abies

A. pindrow in Western Himalayas covers a wider area at lower altitude than that of *A. spectabilis* which grows above it and occupies only smaller regions near the upper tree limit. I have myself observed variation in tree form leaf, cone and scale characteristics of different provenances of *Abies pindrow* and of *A. spectabilis* in Kashmir, Himachal Pradesh and Uttar Pradesh (Dogra Unpubl.).

Brandis (1911) states that the low level fir gradually changes into the high level one on ascending to higher ranges. According to Brandis, the variation is in genetical terms clinal. Except for Kashmir *A. pindrow* is absent from the dry non-monsoon zone. I observed large spreads of forests of only *A. spectabilis* in the dry zone e.g. in Kinnaur, H.P. The dry zone *A. spectabilis* forests differed remarkably from the smaller outer moist monsoon zone ones which are narrowly spread at high level *A. spectabilis* open-stands e.g. stands of Chur range, H.P. (Dogra Unpubl.). In the Eastern Himalayas *A. spectabilis* however forms much larger timber-line forests. It also shows much species diversity in the East but its provenance variation has so far not been properly surveyed or documented. I have observed highly variable populations of *A. spectabilis* differing from each other in tree form, leaf density, length colour and thickness of leaves and in phenology at different altitudes in regions of Darjeeling and Sikkim (Dogra Unpubl.). *A. spectabilis* has very large tree in Eastern Himalayas but in Western Himalayas, the trees of the same species are smaller in size. I have observed that these smaller trees of Western Himalayas have shorter leaves and much denser leaf-arrangement. A distinct variety of *A. spectabilis* var. *brevifolia* Rehder is described and it probably represents the W. Himalayan form of the species (Dallimore & Jackson 1966). In *A. pindrow* rarely occurring abnormal individual mutant seedlings including chlorophyll-mutants have been observed by me in seedling populations in Himachal Pradesh and Uttar Pradesh (Dogra Unpubl.). Mehra & Dogra (1965) report a mutant tree from Shimla which persistently bore only 4-winged pollen grains in all cones every year. Individual tree variants are therefore present in *A. pindrow* and perhaps even in *A. spectabilis*.

In N.W. Himalayas the low level *A. pindrow* and high level *A. spectabilis* are known to hybridize freely and produce polymorphic populations of natural hybrids which show characters intermediate between the two species (Parker 1940, Mehra 1976 and Jain 1975, 1976). Jain (1976) states that F1 progenies might have recurrently back-crossed to their parents and produced introgressants. The hybrids having close affinities to *A. spectabilis* are called by Jain as high level hybrids and those closer to *A. pindrow* as low level hybrids (Jain 1975). Dallimore & Jackson (1966) describes two varieties of *A. pindrow* i.e. *brevifolia* Dallimore & Jackson, and *intermedia* Henry of which the latter shows characters intermediate between *A. pindrow* and *A. spectabilis*. Furthermore *A. pindrow* var. *brevifolia* according to Jain (1976) is probably an introgressant between the two species. In my field survey of high and low level fir populations growing in Jammu and Kashmir Himachal Pradesh and Uttar Pradesh I found the trees, in general, vary in characters between *A. pindrow* and *A. spectabilis* in N.W. Himalayas.

It therefore appears that the two Himalayan fir species are highly variable and only a proper survey of provenance variation occurring within the two or more species and within their respective hybrids can solve their taxonomy. Interspecific hybridization reported to be occurring naturally between the high and low level species in North-western Himalayas must be confirmed by conducting meiotic chromosomal studies of natural hybrid populations and by controlled selfing of hybrids and raising of progeny. Moreover hybridization by controlled interspecific cross pollination must be carried out between the two high and low level species and hybrids raised and analysed.

Cedrus deodara

C. deodara forests are widely distributed in the Himalayas, both in outer wet monsoon zone, and, in the inner dry or arid non-monsoon zones. I studied these forests from both the zones, in the Sutlej and Ganga valleys, and found that the wet zone deodar and the dry zone deodar are different in many silvicultural characteristics. Some low and high altitudinal provenances in both wet and dry zones also differed remarkably from each other. These populations differ in flowering periods, needle size colour and texture, tree form, growth rate, disease resistance and other characters (Dogra Unpubl.). Gorrie (1933) describes 3 forest types of *C. deodara* in the Sutlej valley, i.e.(1) the outer moist zone deodar, occurring in scattered patches or in mixed species forests; (2) the inner dry zone deodar, showing the best pure *Cedrus* forests; and (3) the arid zone deodar, of extremely dry and cold inner cold desert zone. The average rate of growth for each of the three moist, dry and arid deodar types showed great differences. Champion & Seth (1968) describe the 3 types as : (1) the moist deodar forests of N.W. Himalayas; (2) dry zone deodar of Jammu and Kashsmir area and; (3) the dry zone and arid zone deodar of Himachal Pradesh and Uttar Pradesh Suri & Seth (1959) mention that in *C. deodara* seed collected from dry zone, are unsuitable for raising plantations in the moist zone and *Vice versa*. Genetic differences therefore seem to exist between dry and wet zone provenances. A survey study to identify and document, the different altitudinal and latitudinal provenances of *C.deodara* growing in Jammu and Kashmir Himachal Pradesh and Uttar Pradesh is being completed (Dogra Unpubl.). I have obsered rare individual chlorophyll mutant seedling and small populations of trees with uniformly forkedstem which appear to be genetical in both the wet and the dry zone deodar forests of Himachal Pradesh (Dogra Unpubl.). Gamble (1922) and Troup (1921) mention two well marked varieties : one with dark green, and the other, with silvery foliage. The latter variety grows in wild ravines at low level from 1,200-1,800 m in Upper Dharagadha in Jaunsar. Silvery foliage variety was observed by me in two year old plant populations arising from natural regeneration on several sites near Shimla. I have observed the deep dark-green foliage to be characteristic of higher altitude deodar of inner dry zone of Kinnaur. Mehra (1968) reports morphological variation in some trees of *C. deodara*.

Indian Pines

P. wallichiana and *P. roxburghii*, are the most widely distributed pines of India. *P. kesiya* found mostly in Assam in India, is otherwise widely distributed in South-east Asia. Provenance variation is, therefore, expected to be present in all three species. The intrinsic qualities, growth, adaptation and acclimatization potential of the *P. wallichiana* has been described by Dogra (1972). The species is shown to have 7 different types of provenances growing in the Himalayas. The provenances of the dry, extreme North-east, are separated, from that of the wet Eastern regions, by over 1,500 kms Variation in population also exists in different altitudinal provenances because of the high altitudinal range of distribution of the species. These moreover extends over two distinct zones of entire Himalayas : (1) the southern outer, moist zone; and (2) the northern inner, dry zone that falls beyond the reach of the monsoon rainfall. The blue pine provenances, growing in these climatically and topographically different zones, differ in their silvicultural requirements. The seed of the higher level blue pine are unsuitable for growth at lower levels and *vice versa*. Similarly seeds of dry zone prove to be unsuitable for moist zones and *vice versa* (Suri & Seth 1959). Kriebel (1976) has shown that differences occur in cold hardiness of various seed sources sent from various regions and altitudes of Himalayas. Four,blue pine provenances, are described from the western and 3, from the Eastern Himalayas. In the west, the moist lower level, and the moist upper level, monsoon zone provenances, form the largest forests, which spread over the large middle - Himalayan region in the Himachal Pradesh and Uttar Pradesh states. The moist, lower and upper level monsoon zone blue pine forests, show the best growth.In Jammu and Nepal, the middle Himalayan blue pine forests are distributed only in a narrower region at its disposal. In Kashmir, and in inner Nepal, the major blue pine forests therefore grow mostly in the dry zone. The dry, low-level blue pine forests, show the second best growth in India in Kashmir. Himachal Pradesh, Uttar Pradesh and Nepal, are the major blue pine regions in the Himalayas.

A week reproductive barrierr functions between the blue pine populations growing at lower and higher altitudes of both the moist and the dry zones, but a strong reproductive barrier functions between the moist, and the dry zone blue pine populations, which are separated from each other, by the high Himalayan rangers, in Himachal Pradesh and Uttar Pradesh (Dogra 1981). Genotypical differences are therefore expected to be present in the blue pine provenances, growing in India.

Not much is known about the 3 provenances of the Eastern Himalayas except that Bhutan is the major blue pine area of the East and, it has excellent forests of middle moist heavy monsoon zone blue pine. Grierson *et al.* (1980) state that the blue pine is very abundant in the inner, dry valleys between 2,300-2,900 m and in the outer, mesophytic forests between 2,600-3,300 m altitudes in Bhutan (cf. Dogra 1972).

P. roxburghii is extensively distributed in subtropical monsoon belt all along the Himalayas. In the dry, non-monsoon zone, it is absent. Differences between chir provenances, growing in the extremely dry Western Himalayas and in the extremely moist Bhutan in the East (Grierson *et al.* 1980) must exist. Differences in different provenances within its altitudinal range (450-2,300 m) which is fairly wide and spreads over many heterogenous climates and sites ranging from Siwaliks to lower-elevation-areas of the Himalayas must also be present. *P. roxburghii* provenances show significant differences in growth and oleoresin yield and quality. Variation in oleoresin yield and viscosity is seen in different provenances raised at Dehra Dun (Mathaudauda 1956, Kedharnath 1971). In India, the best chir forests are found in Jammu, Himachal Pradesh and Uttar Pradesh. Trees showing spiral grain in wood of *P. roxburghii* are reported to belong to a distinct genetic strain.

P.kesiya is distributed from the elevated regions of Assam Southeast Asia to the mountains of Luzon in the Philippines. Differences in seed origins, of *P.kesiya* from Assam and Burma have been shown to occur in trials conducted in Zambia (Burley & Burrows 1972).

P. gerardiana is restricted to two small pockets of Himachal Pradesh in India. Four distinct forest types have been described from ecologically diffeent dry and arid zones of Kinnaur valley (Dogra 1964).Each has a specific forest structure, and cone bearing capacity. Tree to tree variation also exists. The cones of a tree from Hariab district in the Kurram valley varied from the typical cones because the stout recurved beak of the scales was absent (Brandis 1911). The differences appear to be environmental but genetical factors also seem to have contributed to them (Dogra 1964).

Cupressus torulosa

The species is widely distributed in scattered forests in N.W. Himalayas, W. Szechwan, China. Provenance variation must therefore be present although little is known about it. *C. cashmeriana* Royle ex Carr.not known in wild state is probably a juvenile form of *C. torulosa* which it resembles closely in cones (Dallimore & Jackson 1966). A variety *correyana* (Knight & Perry) Carr. of the species is also described by Dallimore & Jackson (l.c.).

Juniperus

The differences in opinion in identification of various *Juniperus* species of Himalayas are due to natural variation occurring within the species and also within the natural hybrids. The Indian junipers show large distributional ranges in both outer wet and inner dry sub-alpine and alpine zones. They show much intra and interspecific variation in plant form and size ranging from shrubby forms to large trees. The shrubby forms are mostly genetically low growing. The taxonomy of newly created and old species is therefore often disputed.

J. squamata Buch.-Ham.

This species has been considered to be a variety of *J. recurva* Buch.-Ham. It is probably a depauperate form of the latter (Dallimore & Jackson 1966).

J. recurva Buch.-Ham.

The species is widely spread in Eastern Himalayas upper Burma and China and therefore highly variable growing as a shrub or as a tree between 1,700-4,600 m altitudes. *J. recurva* var. *coxii* (A.B. Jackson) Melville is its most vigorous variant found mostly in upper Burma and it is so distinctly different that it is regarded by some to be a separate species (Raizada & Shani 1960). Other variant of *J. recurva* called- *J. squamata* is a depauperate form. The arborescent *J. squamata* var. *fargesii* links the two types. Parlatore united *J. squamata and J. recurva* under a single species in which *J. squamata* was considered to be a variety (Dallimore & Jackson 1966). Mehra & Jain (1976) state that *J. recurva* Buch.-Ham. of Hooker to be a complex of 4 taxa : (1) *J. recurva* (Buch.-Ham.) Mehra et Pathania (*Sensu stricto*), a tree found only in Eastern Nepal; (2) J. squamata *var. fargesii* Rehder et Wilson- a tree-species of E. Nepal, W.Sikkim and Singalila range; (3) *J. squamata* var. *wilsonii squamata* Buch.-Ham. a shrub distributed in Western Sikkim; (4) and the true *J. squamata* Buch.-Ham. a shrub widely distributed in the Western Himalayas.

Juniperus wallichiana

Dallimore & Jackson (1966) state that, the Himalayan species identified as *J.pseudosabina* Hook. f. is actually *J. wallichiana*. Mehra & Jain (1976), however, regard the two *J. pseudosabina* Fisch. et Mey and *J. wallichiana* Hook. f. to be separate species.The latter grows as a tree and the former as a shrub.The tree species, *J. wallichiana*, does not extend to West beyond Nepal, whereas, the shrub species, *J. pseudosabina*, extends both to the Eastern, as well as, to Western Himalayas. Dallimore & Jackson (1966) describes a variety *meionocarpa* Handel-Mazzetti from Sikang and Yunnan, which is doubtfully distinct from the type (Dallimore & Jackson 1966).

Podocarpus neriifolius

The species is highly variable and several varieties namely: *atjehensis* Wasscher, bracteatus (Blume) Wasscher, *degeneri* Gray, *linearis* Wasscher, *membranacea* - Wasscher, *polyantha* Wasscher, *teysmannii* (Miquel) Wasscher and *timorensis* Wasscher have been described from Sumatra, Java,Fiji, Borneo, Celebes and Timor(Dallimore & Jackson 1966). The varieties are easily distinguishable from each other but some present difficulties because they show intermediate characters. A variety called var. *brevifolius* Stapf. is described to occur in the Himalayas, Khasi hills and in Eastern Indian region. The tree of *P. neriifolius* occurring in high hills of Andaman remain stunted but elsewhere the trees attain good dimensions and yield fine timber.

Taxus baccata

The species is widely distributed extending uniformity both in the Western and Eastern Himalayas in a wide latitudinal and altitudinal range (5,000-12,000'). *T. baccata* is highly variable consisting of shrubby to large sized trees. Large trees are however not very common and the species does not form extensive pure forest. A narrow leaved form of *T.baccata* is recorded from the Himalayas (Raizada & Sahni 1960).

Discussion

Wild gene resources of most of the conifer species are still available as natural tree stands in the Himalayas but they are being depleted at an alarmingly fast rate. The planted forest stands have also not undergone much genetic change and they too are, therefore, mostly wild in origin. Natural gene resources of different provenances can therefore be surveyed selected documented and multiplied for forest plantation and tree breeding work.

Field data on wild gene resources of conifers of Himalayas presented above shows genetic diversity to be common in many species. The choice of seed origins used in experimentsss, plantation work and in choice of parents for hybridization is sometimes neglected. The data presented on wild gene resources of conifers of Himalayas shows how variable the seed origins can be in species like *Pinus wallichiana*, *Cedrus deodara* and *Pinus kesiya*. *P. wallichiana* provenances show variation for resistance to blister rust caused by *Cornertium ribicola* J.C. Fisch. ex Rabenh. The resistance to blister rust and further breeding value of hybrids raised from interspecific crosses with such provenances will depend upon the genotype of *P. wallichiana* selected from its range and used for crosses (Heimburger 1961). Thus the resistance to blister rust is seen to vary with different hybrids of a combination.The provenances of *P. wallichiana* of lower altitudes of Himalayas taken to Northern Japan showed unsatisfactory growth because the winter of Northern Japan proved to be too severe for them(Saho 1972). Kriebel (1976) found that seed origin of the species from different regions of Himalayas differed in cold hardiness at Ohio.Seed origins of lower altitude provenances of Eastern Himalayan *Picea spinulosa* introduced in U.K. proved to be not hardy but seed origins of higher elevations if introduced would be hardier (Dallimore & Jackson1966). Due attention must therefore be paid to seed source within species. Provenance research and control of seed origins are therefore basic for conifer breeding programmes particularly of widely distributed species like *Pinus wallichiana*, *P. roxburghii*,*P.kesiya*, *Cedrus deodara*, *Abies pindrow*, *A. spectabilis*, *Picea smithiana*, *P. spinulosa*. Wild gene resources of Himalayan conifers are rich in the form of natural forests and planted stands. The planted stands are genetically not much different from those of natural forests as they too are wild in origin. Provenance research, trials and selections, with selection of plus trees, seed stands and seed areas of races will provide a sound basis for the use of proper seed sources in breeding and improvement work.

Provenance work must be followed by establishment of seed orchards for production cf genetically superior seed for use in demarcated geographic unit areas within which genetic seed can be moved. Germplasm multiplication and conservation is a practical step requiring special effort. Work on vegetative propagation of Himalayan conifers and its physiology must receive special attention in which raising of rooted cuttings and stalk scion grafting techniques need to be developed for cloning of genotype.

Controlled hybridization between genetically outstanding selected races and provenance of many widely distributed conifers such as of *Abies pindrow, A.spectabilis, Picea smithiana, P.spinulosa, Pinus wallichiana, P.roxburghii, P. kesiya, Cedrus deodara, Tsuga dumosa* and Juniperus spp.can yield profitable results.

Many closely related conifer species do not show strong genetic barriers to controlled interspecific crosses. There is not much distinction between 4 species of *Cedrus*, namely : *C. libani* A. Rich., *C. atlantica* (Endl.) Carr., *C. brevifolia* (Hook. F.) Henry and *C. deodara* (Roxb.) D.Don. These are considered to be geograpical sub-species or varieties of *C. libani* (Dallimore & Jackson 1966). No attempt has so far been made in India to cross them. Natural hybridization occurs between several *Juniperus* species and inter-specific hybrid swarms have been reported to occur in regions of overlap. Himalayan tree junipers can be subjected to controlled crossing. Genetic affinity between several *Abies* species is close and if brought together they intercross. Naturally growing interspecific hybrid swarms of *A. pindrow* and A *spectabilis* are reported in the Western Himalayas (Parker 1940, Mehra 1976, and Jain 1976). *Larix griffithii* Hook. f.is closely related to *L. potanini*; and similarly *Pinus roxburghii* to *P. canariensis; P. gerardiana* to *P. bungeana;* p. *kesiya* to *P. tabulaeformis*; and P. *wallichiana* to *P. ayacahuite,* P. *monticola, P. strobus, P. peuce, P. paryiflora* and *P. flexilis*. Geographic separation functions as the chief reproductive barrier between these closely related species. This can be overcome by controlled pollination. This is shown by systematic crossability studies conducted between *Pinus wallichiana* and the six closely related pines mentioned above (Bingham 1967) and between *P. kesiya* and *P. tabulaeformis* (Wright 1962) and *P. roxburghii* and *P. canariensis* (Righter & Duffield 1951).

The genetic potential of selection of best wild gene resources establishment of seed orchards and intra-and interspecific hybridization of Himalayan conifers remains so far untapped for tree breeding work in Indian forestry.

SUMMARY

There are about 11 genera and 24 species of conifers native to India. only 4 genera, *Abies, Cedrus, Picea* and *Pinus* form extensive forests. Distribution, natural variation and species diversity are described. An assessment of their wild gene resources is made on the basis of field observation in the Himalayas for conifer breeding work. It is shown that intraspecific variation is common in many species especially in the widely distributed ones. Provenance research and control of seed origins are considered to be essential for selection and choice of parent trees in intra - and interspecific hybridization work.

भारत में शंकुधर वन और वृक्ष प्रजनन के संदर्भ में उनके जंगली गुणसूत्र (जीन) संसाधन

पी० डी० डोगरा

सारांश

भारत में शंकुधरों की लगभग 11 प्रजातियां और 24 जातियां देशज हैं। केवल चार प्रजातियों, एबीज, सीडरस, पीसिया और पाइनस के विस्तृत वन हैं। इनका विस्तार, प्राकृतिक विभिन्नताएं और जातिगत विभेद बताए गए हैं। हिमालय क्षेत्र में शंकुधर प्रजनन कार्य के सिलसिले में किए गए क्षेत्र पर्यवेक्षण के आधार पर इनके जंगली गुणसूत्र संसाधनों का आंकलन दिया गया है। यहां पर दिखाया गया है कि अनेक जातियों में जात्यान्तर विभिन्नता आमतौर से पाई जाती है विशेषतया दूर-दूर तक फैली हुई वृक्ष जातियों में। जात्यान्तर और जाति-बाहुय प्रसंकरण के लिए मातृ वृक्ष की छांट और चुनाव के लिए बीजोद्गमों का स्थान-अनुसंधान और उनका नियन्त्रण करना अनिवार्य बताए गए हैं।

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PEST MANAGEMENT IN INDIAN FORESTRY

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Introduction

Forests in India occupy nearly 75 million hectares, constituting roughly 23% of the total land area. However, reports in recent years indicate that the area actually under forest cover is no more than 10% (Kamath, 1985). A large portion, is in fact waste-land and which needs to be harnessed and brought under tree cover. This, by itself, may not be sufficient to meet our ever-increasing requirement of woody raw material of nearly 200 and odd wood based industries, fodder, fuelwood and small timber requirement of human populace, particularly that living in the country side. This calls for intensive management of production forestry, including protection from various bio-deteriorating agencies.

Among the various agencies, which play significant role in limiting the forest productivity, insect pests constitute an important single factor and are known to attack all stages of forests from the seeds to the finished products, resulting in callosal economc loss. Quite often, these pose serious problems and constraints in protecting our forest resources, particularly in forest nurseries, plantation forestry and timber storage areas. Right from the very inception of forest Entomology as a separate discipline at the Forest Research Institute in the begining of this century, major emphasis had been to evolve suitable control measures for forest pests, particularly for the recognised key pests. This paper reviews various aspects of pest management strategies followed so far and highlights some of the possible future lines of approaches in pest management.

Major pests of forestry importance

Though management of forest resources on scientific lines was taken up during the later half of nineteenth century, Forest Entomology as a discipline gained recognition only by the end of nineteenth century, when E.B. Stebbing was appointed as Forest Zoologist in the year 1900. During the early formative period, greater emphasis was laid on establishing the identity of forest insect pests, studying their life histories and wherever possible, evaluation of losses.

Important and major insect pests which received greater attention and were worked out intensively, belonged to (i) defoliators of Ailanthus (Atteva fabriciella Swed., *Eligma narcisus* Cramer), Gamhar (*Calopepla leayana* Latr.), Kadam (*Arthroschista hilaralis* Walk.), Khasi pine (*Dichocrois punctiferalis* Guen.), *Euterusia pulchella* Koll.), poplars (*Pygaera cupreata* Butler, *P. fulgurita* Walk.), teak (*Eutectona machaeralis* Walk.), *Hyblaea puera* Cramer); (ii) Shoot borers of Meliaceae (*Hypsipyla robusta* Moore), semul (*Tonica niviferana* Walk.); (iii) stem and root borer of babul and Eucalyptus (*Celosterna scabrator* Fabr.), poplars (*Apriona cineria* Chevrolak); (iv) sal heartwood borer (*Hoplocerambyx spinicornis* Newm.), teak (*Dihammus cervinus* Hope) as well as borers of felled and converted timbers.

Among the nursery pests, the most important one are the white grubs (*Apogonia nigricans* Hoop, *Holotrichia consanguinea* Blanchard, *H. serrata* Fabr. and *Lachnosterna* spp.), cutworm (*Agrotis ipsilon* Fabr.) and termites. The white-grubs are well known pests of agricultural crops, but their importance as forestry pest has been realised in recent decades only. The larvae damage the roots, resulting in the death of the affected plants. The greasy cutworm (*Agrotis ipsilon* Fabr.) causes heavy mortality to the nursery stock of most of tree speceis, particularly tropical pines (Bakshi, 1975; Sen-Sarma, 1980; Sen-Sarma & Thakur, 1985). Though termite damage in well managed nurseries is generally insignificant, but at times, under favourable conditions, they cause serious losses, often leading to abandonment of forest nurseries in certain localities (Thakur & Sen-Sarma, 1980; Thakur, 1983).

Pest management strategies

It is generally said that forestry is ninety per cent protection (Graham, 1952). It may be an over exaggeration of the problem to some extent, but it does highlight the importance of protecting the forest resources from various biodeteriorating agencies. (Sen-Sarma & Thakur, 1985). Most of forest pests in the tropics have very high biotic potential, short life cycle, with many overlapping generations in a year. These biotic characteristics in pest species help them to multiply incredulously, leading at times, to epidemic situations. The problem is more pronounced in cultured forestry, where the situations vary widely both in stability and complexity. In addition, growing of unsuitable plant species on improper unhygienic, localities, coupled with faulty planting techniques and cultural practices followed, have not only resulted in poor growth rate, but have also helped some of the obscure pests to become key pests and cause serious losses in forest productivity. Any one or a combination of more than one factors becomes the causative agent

agent for loss in growth, mortality and or predisposing the plant species and making it vulnerable to pest damage. It is, therefore, essential that all economic entomologists arm themselves with a thorough understanding of the sylvan ecosystem, before eolving any suitable pest management schedules.

Chemical control with organic compounds were relatively unknown during the first three decades of this century, naturally, therefore, the main emphasis was on developing natural nontoxic methods of pest control. Maintenance of forest and/or storage hygenic conditions, safe felling periods, debarking (to prevent oviposition by borers), starch depletion, proper storage (Storage in log ponds or intermittent sprinkling of water) were some of the methods devised and employed to prevent insect damage.

(a) *Cultural Control* : Forest Entomologists in early thirties took note of the existence of certain traits of pest resistance and pest avoidance in plants and manipulated them to the serious disadvantage of the pest species. Most of the plant species exhibit certain degree of unpalatability, eg. hardness of leaf lamina and shoots, sap density or presence of chemical compounds (alkaloides and phenolic compounds), gums, resins, latex, etc. (Beeson, 1941; Thakur, 1983; Sen-Sarma & Thakur, 1985). Inducing early or late sprouting, leaf fall as well as acquiring new foliage just after defoliation, are some of other traits which were exploited by introducing suitable cultural practices. For example, *Dalbergia sissoo* growing under irrigated plantations, sprouts early when irrigated before the advent of the first generation of the pest *Plecoptera reflea, Guen.*, thus resulting in heavy mortality. Similarly, grub populations in forest nurseries were controlled by adopting some appropriate cultural practices, which include (i) preparation of nursery beds one month prior or later to the swarming period of beetle populations, (ii) sowing of seeds without disturbing the soil, (iii) scheduling of weeding operations and application of soil insecticides. The crawling populations can be eliminated by trapping in narrow earthen pots sunkened in between the seed beds.

(b) *Silvicultural cum Biological Control* : Some of the insect outbreaks were controlled by adopting suitable and effective silvicultural practices and in some cases, this method, when combined with biological control, proved highly effective and successful. As a rule, silvicultural control can be successfully implemented by eliminating or manipulating certain factors which may be conductive to the build up of pest populations. Some of the factors, which ensure healthy and abundant growth, have been identified as (i) suitable site selection, (ii) choice of correct tree species, (iii) favourable and hygienic conditions in forest nurseries,(iv) safe transporting of nursery stock and adopting correct planting techniques,(v) avoiding at the same time planting of collateral hosts of pests and (vi) encouraging admixture of beneficial and desirable tree species, etc.

Over the years, evidence has been accumulating favouring mixed stands in the forest ecosystems, because such stands are less prone to insect epidemics (Graham & Knight, 1965), in contrast to intensively managed cultured forests of preferred plantation species growing as evenaged stands and which are exposed to greater risks of insect outbreaks (Bakshi, 1975; Sen-Sarma & Thakur, 1985). For example, the concept of silvicultural cum biological control for teak defoliators developed in thirties, where the epidemics of the key pests in teak plantations were controlled and brought below the economic thresh hold by having admixture of desirable species, holds good even today. The incidence of insect outbreaks in pure stands of teak, as also in other tree species has been recorded very high as compared to mixed stands, where biotic elements responsible for regulating the ecosystem function more effectively. However, care should be taken to avoid mix planting of collateral hosts of the pest species as it is likely to increase the incidence of pest attack. For example, the incidence of teak canker grub, *Dihamus cervinus* Hope is invariably very high in areas having mixed plantations of *Gmelina arborea* and teak. Plantation sites, which are not fully cleared of *Clerodendron infortunatus*, a collateral host plant, are also prone to high incidence of borer attack. Similarly *Eucalyptus* plantations growing adjacent to or in areas previously occupied by *Acacia* spp. are liable to become the target of root and stem borer, *Celosterna scabrator* Newm.

(c) *Chemical Control :* Since 1945, pest management took a big lead in the development of various synthetic chemicals, which are found highly effective in controlling pest species. The introduction of monoculture concept brought in its wake many problems of pest management. Pest control by the application of synthetic organic chemical compounds proved handy and quick solution to most of the pest problems. This revolutionised and accelerated the process of development of numerous pesticides, belonging to chlorinated hydrocarbons, organophosphorous and carbamate compounds. Most of them, though highly effective, have been found to possess high mammalian toxicity and some of them, such as chlorinated hydrocarbons are highly persistent in nature with high residual toxicity. It is, therefore, not surprising, that man is becoming aware of environmental hazards of these chemicals and has started realising the necessity to adopt preventive as well as corrective measures to reduce/minimise the ecological impact of pesticidal applications.

(d) *Microbial Control :* During fifties and after, other useful non-toxic pest methods were evolved by using safer pest methods like microbial control. Many natural pathogens such as viruses, bacteria and some pathogenic fungi, of important key pests of forestry have been screened and exploited more profitably. The use of microbial insecticides, e.g. certain strains of bacterium *Bacillus thuringiensis* or the fungus *Beauvaria* spp., particularly *B. basiana* against many lepidopterous pests have been found successful. The efficacy of some of these e.g. *B. thuringiensis* or similar products has been enhanced by additives, like "*chitinase*" which hydrolyses the chintious wall of the target larvae. Recently, Ahmad & Sen-Sarma (1983) isolated naturally occurring Nucleus Polyhedroses Virus (NPV) from the larvae of *Pygaera fulgurita* Wall. and have used crude suspension successfully for suppressing the population of the pest.

(e) *Behavioural Control :* Exploitation of insect behaviour for pest control has been in vogue since long. For example, tree trap method, devised for controlling epidemics of sal heartwood borer, *Hoplocerambyx spinicornis* Newm. in thirties is being followed even today. The concept of "*PAKKARO AUR MARRO*" (trap and kill), though looked very odd a few decades ago, is the only successful method of controlling the population of this borer as it has defied all other methods of control. Pheromone traps and light traps which are now being increasingly used for monitoring of pest populations,also assist in the control. The crawing female population of *Ectropis deodarae* Prout, an important pest of deodar, is also being trapped by the use of sticky-band around the stem of deodar trees.

These are some of the significant pest control methods which have been very commonly used in forestry with varying degree of success. Development of pest management strategies is a continuing process and newer methods are being evolved as the situations demand.

Future research approaches in pest management

With growing awareness about the environmental hazards of pesticidal applications and partial success in other methods of pest management strategies, it was realised in early fifties that the concept of single method control was not sufficient to provide complete protection against most of the forest pest problems. It was only then, that the concept of "*Integrated Pest Control*" (IPC) was conceived as a tool for pest management and this generated a great deal of interest among the economic entomologists all over the world.

The concept of integrated pest control has been defined by the FAO (1968, 1973), as "a pest management system, that in the context of associated, environment, and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economic injury". According to Geier (1983), the pest management, under the system, operates by transforming certain inputs (preventive measures) into corresponding outputs (effective protection) subject of course, to governing constrains (biological, technological, socioeconomic determinants and limitations). A successful pest control operation should, therefore, include all the these elements, suitably integrated with the functional requirements of the production system(s). In a way, whether this is achieved by adopting a single component control method or the most sophisticated and complex control method, will depend upon the requirements of the specific situations.

The main component in integrated pest management are (i) keeping the pest population below the economic level of injury, (ii) surveillance and detection of pest incidence, (iii) use of pest resistant plant species, by following sound tree improvement programmes, and (iv) limited and need-based use of pesticides and avoiding pesticidal applications during the period when the pest enemies are dominant (Brader, 1979).

The concept and development of integrated pest management in India, as in other developing countries, has more relevance, bacause the physical environment, which is by and large tropical and subtropical in nature, offers ideal conditions for the development and building up of pest populations for greater part of the year and at the same time creat equally optimum conditions for the biotic elements, responsible for regulating the ecosystems, occurring naturally in abundance to function effectively. Of late, (Geier, 1983) mult-disciplinary or trans-disciplinary approaches are also gaining favour as pest management tools. More and more scientists are now acknowledging the importance of these approaches in developmental programmes. Scientists of different disciplines tackle a single problem without being co-ordinated as team (multi-disciplinary approach) or as in trans-disciplinary approach, where different disciplines are used in a well coordinated interaction attempt to tackle the problems of the pest management.

Discussion and Conclusions

Long term perspective planning for increased production can be achieved either by increasing the acreage under forest cover or/and by increasing the production per unit area over the existing acreage (FAO, 1973). Though, for Indian conditions, there is a scope, to a certain extent, to increase acreage under forest cover and Govt. has already taken steps to bring five million hectares of wasteland under tree cover every year, but, at the same time, there is also a need to intensify efforts for increased productivity by adopting sound management practices. In addition, it is also important to evolve successful biological and biocidal controls for large number of forest insect pests and to interlink them into the chain of integrated pest control. The use of pesticides in forestry, particularly aerial applications over large areas of natural forest and plantations, may be discouraged as far as possible, and should be resorted to, only for supressing the threatening epidermics (Thakur 1983; Thakur & Sen-Sarma, 1985). The logical approach, therefore, is to encourage pest restraining mechanism by planting pest resistant plant species under silviculturaly favourable conditions and adopting crop rotation system as a regular measure in plantation schemes. This will help in recycling soil nutrients for new crops and will also replenish the nutrient losses.

SUMMARY

India has been loosing nearly 1.5 millions hectares of forest cover annually, which is a warning for increased desertification in the Indian subcontinent. Therefore, while there is a need to increase the acreage under forest cover, it is also necessary to manage intensively our forest resources for increased productivity by following various management practices, including protection from various biological agencies. Among the various such agencies, insects constitute an important single factor, which limit the forest productivity. Various methods were evolved for controlling the forest pests right from the very inception of forest Entomology branch. This paper discusses in details the pest management strategies followed so far and the role played by each method in controlling the forest pests. Future line of researches have been indicated laying greater emphasis of well coordinated integrated pest management through multi-disciplinary or trans-disciplinary approaches.

भारतीय वानिकी में नाशिकीटों का प्रबन्ध

पी० के० सेनशर्मा व एम० एल० ठाकुर

सारांश

भारतवर्ष की लगभग १५ लाख हेक्टेयर वन उपज प्रतिवर्ष बरबाद जा रही है जो भारतीय उप-महाद्वीप के निरन्तर बढ़ते जा रहे मरुप्रदेश को देखते हुए एक गंभीर चेतावनी है। इसलिए जहां वन क्षेत्र बढ़ाने की बहुत आवश्यकता है वहां अपने वन संसाधनों में विभिन्न प्रबन्ध प्रक्रियाएं अपनाकर जिनमें विविध जैविकीय अभिकरणों से उनकी सुरक्षा करना भी आ जाता है, उनसे अधिक उत्पादकता लेने के लिए उनका सघन प्रबंध करना भी आबश्यक है। ऐसे अभिकरणों में सबसे मुख्य कारण कीड़े हैं जो वन उत्पादकता को कम करते हैं। वन कीट

विज्ञान शाखा ने प्रारम्भ से ही वन के नाशिकीटों का नियन्त्रण करने के लिए अनेक उपाय विकसित किए हैं। प्रस्तुत अभिपत्र में अब तक अपनाई गई विविध प्रबन्ध नीतियों और वन नाशिकीटों के नियन्त्रण में प्रत्येक रीति की भूमिका की विस्तार में विवेचना की गई है। भविष्य में किए जाने वाले अनुसंधान का दिशा संकेत किया गया है जिसमें विभिन्न विज्ञानों या अन्तर- विज्ञान दृष्टियों को अपनाकर सुनियोजित एकीकृत नाशिकीट प्रबन्ध करने पर अधिक जोर दिया गया है।

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INDUSTRIAL USE OF RECENT PLANTATION AS AN ALTERNATIVE TO CONVENTIONAL RAW MATERIAL

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Introduction

Supply of conventional raw-material for wood based industries is shrinking day by day. All the three major wood based industries viz. mechanical wood products, pulp and paper and panel products industries are today starving of raw material. The remedy lies in (i) substituting wood by other raw materials where-ever possible, (ii) use of more and more non-woody ligno-cellulosic materials for pulp, paper and panel products industries, (iii) use of non-conventional secondary, and tertiary species for different end uses and (iv) resort to fast growing exotics or plantation woods to replace conventional species. Some head-way has been made in this direction in the recent past. Pulp and paper industry which is the largest consumer of ligno-cellulosic raw material of forestry origin has been shifting from bamboo to mixed hardwoods and then to grasses and agricultural residues like bagasse. Panel products like hardboards, fibreboards and particle boards are now progressively being made from non-woody raw materials,lops and tops of trees etc.More and more railway sleepers are now made of iron and concrete. Iron frames for doors and windows and steel, aluminium and plastic furniture are becoming popular day by day. For use in mechanical wood products industries like joinery, furniture, construction, sports goods, juit and textile mill accessories, a large number of secondary and tertiary species have been evaluated, processing techniques developed or modified where necessary and the use of these species of timbers to replace primary timbers has been standardised (Tewari & Jain, 1980; Rajput & Shukla 1984).

To reduce the pressure on already over exploited forests and to maintain them at a appropriate level so as to save the environmentand ecosystem, large scale plantations of several fast growing species have been initiated in different parts of the country. As a result upto 1979-80 an area of about 3.56 million ha., out of 5.71 million ha. targeted upto 1984-85, was already afforested wth fast growing species under different Forestry Development programmes (3). Starting from 1985 - 86 there is a massive programme of plantation of 5 million ha. of land annually under VII five year plan. Among the species which have been planted very extensively, mention may be made of eucalypts, poplars, tropical pines, acacias, casuarina etc. (Ghosh 1977). While part of these plantations are basically meant to reduce the pressure on existing forests to meet the growing demand of fuelwood, remaining are to be diverted to raw material starved wood based industries like paper, panel products and for solid wood utilisation like construction, joinery, furniture etc.

Studies have been undertaken recently at the Forest Research Institute to determine the suitability of these plantation woods for different industrial uses and to modify the processing techniques and production processes to make them suitable for using for different purpose. The results of these investigations have been reviewed in the following paragraphs species wise. The important strength properties of some of the species have been reported in Table 1 and suitably indices in Table 2.

Acacias : Among the main acacias which have been planted in different parts of the country with dry and moist tropical and temperate climatic conditions,are *Acacia auriculiformis*, *A. dealbata*, *A. mearnsii* and *A. tortilis*. only *A. tortilis* has so far been tested for strength properties and has been found to be weaker than other timbers of similar weight (Shukla and Sangal). Strength-wise it is suitable for construction as a group C species as per classification of timber for structural purposes codified in Indian Standard code of practice for design of structural timber in building, IS : 883-1970. Some studies have also been done on utilisation of *Acacia auriculiformis* (Rajan *et. al*, 1979) and this species seems to be very promising for turnery work. Paper making qualities of *Acacia auriculiformis* have also been studied (Guha and Pant, 1966) and this species has been found to be suitable for making writing, printing and wrapping paper.

Casuarinas : Among different species of casuarina, *C. equisetifolia* grows well in tropical moist and coastal regions and its plantations have been raised in Gujarat, Madhya Pradesh, Maharashtra, Orissa, West Bengal and states of South India. Strength tests have indicated that the timber is very heavy, moderately strong, tough and very hard. It is suitable for posts, mine props, poles etc. Full length poles of the species have also been tested from Maharashtra and the species is found to be suitable for transmission poles. (Sekhar and Gulati 1972). The species has low durability, heartwood very refractory to treatment, penetration of preservative being practically nil from sides or ends. It is also highly refractory in seasoning, (IS :

401-1982, IS : 1141-1973). Chemical semi-chemical and mechanical pulps have been successfully developed from this species and its suitability for paper making has been demonstrated (Guha & Karira, 1981).

Cupressus : Among differen species of cupressus, *C. torulosa* has been planted in temperate and sub-tropical regions of J & K, U.P. Nagaland and Arunachal Pradesh. As per strength tests, it is moderately heavy, moderately strong and soft wood. It is highly durable species, easy to season with low refractoriness. Kiln seasoning standard schedule No. III is suitable for its seasoning (IS : 401-1982, IS : 1141-1973). It is suitable for construction (Group C), furniture joinery, picture frames, packing cases, drawing boards, turnery, pattern making and general planking (Rajput & Shukla 1984).

Eucalypts : Several species of eucalypts have been tried extensively throughout the length and breadth of the country. Among the eucalypts, most promising are *E. tereticornis* (specially the Nandy provenance popularly known as E. hybrid) *E. camaldulensis*, *E. grandis* and *E. citriodora*. In addition two hybrid varieties of eucalypts developed by Forest Research Institute and named as F.R.I. 4 and F.R.I. 5 are also promising. In many states led by Punjab and Haryana, eucalypts have been extensively planted on road sides, canal beats and along railway lines. This is because of their easy adaptability to varied soil and climatic conditions, vary fast growing characters and requirement of least protection measures against cattle etc. A large number of investigations on evaluation of physical, mechanical, working, seasoning, durability treatability, peelability, glueability, and paper making qualities have been undertaken at this Institute. Physical and mechanical properties of these species have been evaluated from several localities Shukla & Rajput 1983).

hybrid) is

E. tereticornis (*E. hybrid*) is 10% heavier than teak, moderately strong, not tough, and hard timber. *E. camaldulensis* is slightly superior to E. hybrid. E. hybrid has been found to be highly refractory timber developing severe collapse, surface cracks, warping and twisting during seasoning. However, it has been demonstrated that these defects are almost completely eliminated when radial sawing method of conversion is adopted. Suitable seasoning schedule with and without chemical treatment has been developed for its degrade free seasoning (Pande *et al*, 1984). The species belongs to non-durable and non-treatable class which is the greatest drawback for its diversified utilisation. Under machining operations E. hybrid can very well machine planed, turned, bored and mortised. It's working quality index is 94 and finish adaptability 104 as compared to teak as 100. Particle boards, hardboards and plywood have been developed from the species with appropriately modified techniques and process parameters determined. Suitable processing techniques have been developed to make *E.* hybrid suitable for match splints and the process has been successfully employed by the industry (Kumar *et al* 1981). Wood-wool boards have also been developed from this species. Some trees of this species yield cineole rich medicinal oil. The bark of the species is a source of oxalic acid. The species is suitable for overhead power and telecommunication lines, pallets, scaffolding, tool handles and other agricultural implements, joinery, simple as well as bent wood furniture articles, and even for carving (Rajput & Tewari 1984). For construction, eucalyptus fall under group C to B taking into consideration variability in strength of all the eucalyptus tested so far. (Rajput *et al*).

Eucalyptus have been evaluated extensively for pulp and paper including studies on chip size and its effect on paper quality (Sharma and Bhandari 1983, Bahri 1983). All the above four species viz. *E. tereticornis, E. camaldulensis, E. citriodora* and *E. grandis* have been pulped under different processes and optimum process parameters for developing pulps for different grades of paper have been worked out. The results conclusively indicate that eucalypts provide excellent raw material for paper industry. *Musiz : Maesopsis eminii* has been planted in Karnataka and also in Andhra Pradesh and Tamil Nadu as a shade trees in coffee plantations. Strength tests have indicated (Ananthanarayana & Jain 1982) that the timber is weak, moderately heavy, not tough and poor in retention of shape. It turns and finishes well. The timber is suitable for light packing cases, crates, turnery articles and some types of tool handles. It is classified under Group C for construction purposes.

Oaks : Among Oaks, *Q. leucotrichophora* (Syn. *Q. incana*) and *Q.serrata* are being planted in states like U.P. and Himachal Pradesh. Strength tests have indicated that *Q. leucotrichophora,* though heavier but is generally weaker than teak. The species is classified as heavy, moderately strong, tough and hard. It is recommended for construction work,poles, ballies, tool handles, anvil blocks, mallet heads and agricultural implements (Rajput & Shukla 1984).Mixture of oaks has been found, on pilot scale,tobe suitable for making paper. Rayon grade pulp has also been produced from oaks (Guha *et al,* 1970, 1971).

Pines : Several species of tropical pines have been tried in some states. Among tropical pines mention may be made of *P. caribaea,P. elleottii, P.oocarpa* and *P. patula*. In addition species like *P. kesiya* have been introduced in areas out side their natural habitat, specially in states like Orissa. Strength tests on plantation grown *P.kesiya* from Orissa indicate that it is stronger than natural grown wood of Nagaland. It is moderately heavy, weak, not tough, moderately steady and soft. For construction purposes, it is classified as Group C species. Its Composite Sleeper Figure is 50 as against 48 minimum value acceptable for suitability (Bali *et al*, 1984). General analysis of strength of *Pinus caribaea* and *P. patula* indicates that these are suitable for packing cases, crates, false ceiling and partition work etc. (Shukla 1982). Studies on pupling and paper making qualities of tropical pines indicate that pulp in good yields and with good strength properties can be prepared by Kraft process and as such tropical pines can be successfully utilised for production of writing wrapping and printing papers. (Guha 1982, Sharma and Singh 1982).

Poplars : Large scale plantations of *Populus yunnanensis, P. nigra P. deltoides* and *P.x euramericana* have been raised in U.P., J & K, Himachal Pradesh, Punjab and Haryana states in the areas with subtropical and temperate climate. In states like U.P., poplars have been raised extensively by farmers under agro-forestry programmes. Most of these plantations have been raised by the farmers in view of the large scale demand of poplar wood by match industry. Strength-wise poplars are suitable for packing cases (Shukla 1979). For construction, its strength falls little short of the minimum recommended in IS : 883 (Shukla & Sangal). However, it could be used in suitably increased sections for rafters, purlins etc. Populus species as such is reported to be suitable and recommended in Indian standards for tennis and badminton rackets, squash racket frames, matches and artificial limbs (Rajput and Shukla 1984). Experiments are in progress for studying suitability of *P.deltoides* des for plywood. The results so far indicate that it can produce good quality plywood for different uses. Poplars have been tested for their paper making qualities also. Suitable process parameters have been determined for use of poplars for manufacture of writing and printing paper (Rai & Sharma 1983). Studies on whole tree (young plantations) utilisation of poplars for pulp and paper and panel products are also in progress and the results are encouraging.

Prosopis : *Prosopis chilensis* (syn. *P. juliflora*) has beenplanted in some areas of dry tropical climates in the states like Gujrat, M.P., Rajasthan, Punjab, Haryana and U.P. From the limited tests undertaken earlier (Sekhar and Rawat 1960), the species is found to be strong, hard and tough and is very suitable for construction (Group B), tool handles, agricultural implements, blocks and crushers as well as many other uses where strength and hardness are main requirements. Further tests are in progress.

Robinia : *Robinia pseud-acacia*

has been planted in several areas of J & K, Himachal Pradesh and U.P. Strength tests indicate that the species is heavy, strong, extremely tough and very hard. As such it is suitable for construction (Group C) flooring, tool handles, poles, fence posts etc. (Shukla *et al*). Under seasoning, it is moderately refractory (IS: 1141-1973).

Rubberwood : *Hevea brasileinsis* has been planted in Kerala, Tamil Nadu and Karnataka. Some plantations have also been tried in Andaman & Nicobar, Assam, Tripura and Goa. According to strength tests, the species has been found to be heavy, weak, moderately hard (Shukla & Lal 1985). It is easy to work and takes polish satisfactorily. Ammonia treated wood also takes good polish and the species is suitable for bent wood furniture and other such articles (Shukla *et al*, 1984). The species is suitable for packing cases, crates, construction (Group C), furniture items of moderate quality, bobbins, compressed wood shuttles, footwear bottom etc. The species has been successfully seasoned and a modified schedule V (IS : 1141-1973) has been developed for its kiln seasoning by increasing the relative humidity by about 7% and giving initial steaming for two hours at 45° C and 100% R.H. and final steaming for three hours at 55° C and 100% R.H. (Sharma and Kukreti 1981). A suitable process for making match splints from rubberwood has also been developed. The species is not durable but is easily treatable.

Sahjan : *Moringa oleifera* (Syn. *M. pterygosperma*) is suitable for - tropical moist climates and its plantations have been raised in sub-Himalayan regions of U.P. *Moringa oleifera* has been evaluated for its suitability for wrapping, printing and writing paper (Guha &Negi 1965). Mechanical pulp for newsprint grade paper has also been successfully developed and process parameters have been determined (Guha *et al*, 1968).

Subabul : Trial plantations of *Leucaena leucocephala* have been raised in several states like Maharashtra, Gujarat, Rajasthan, U.P. etc. From the meagre test results available the species seems to be suitable for tool handles, wooden pegs, tent pins, fence posts and possibly even for sport goods. The species falls under group C for construction purposes (Shukla 1982). The species has been extensively tested for its pulp and paper making qualities. Kraft pulping of the species for development of writing and printing paper has been done (Bhola and Sharma 1982). High yield pulps have been obtained (Sharma *et al*, 1982) and also high alpha cellulose pulp has been produced (Sharma *et al*, 1984). Detailed studies on variation of fibre vessel characteristics of subabul and their influence on paper strength have also been undertaken (Singh *et al*). The species provides an excellent raw material for paper making.

Suji : Cryptomeria japonica has been planted mostly in the upper hills of West Bengal. The species has been found to be very light and very steady and is suitable for very light packing cases, veneered wood boards, sandwich panels, insulation purposes, ice cream spoon etc. (Shukla and Lal). It is non-refractory species under seasoning, heartwood non-durable as well as non-treatable. Chemical, semi-chemical and mechanical pulps have been successfully obtained from this species and the species is found to be suitable for production of writing, printing and wrapping paper (Guha *et al*, 1970).

Conclusion

Data on wood consumption pattern in India, rapid depletion of forests and scarce availability of conventional industrial wood stress the need for dynamic, integrated and long term plan for promoting alternative species, wherever possible, in the field of wood based industries. In order to meet the growing demand of industrial wood, the use of promising non-conventional species as raw material should be encouraged.

A great emphasis is being laid by Government for achieving Self-sufficiency in forest production as early as possible. Plantation of fast growing species to meet the demand from various sectors is one of the important forest development activity. The result of investigations carried out at F.R.I., as reported above, clearly indicate that some of the species, being planted currently, can substitute the conventional species for various industrial uses.

It would thus be seen that rational use of all types of these species will definitely release pressure on the conventional species and will have a positive effect on the supply of raw material for several wood based industries.

SUMMARY

Supply of conventional raw material for wood based industries is shrinking day by day. The solution lies in the use of alternate raw materials. Plantations of several fast growing species have been done on a large scale in different parts of the country. While parts of these plantations are basically meant to reduce the pressure on already over exploited forests to meet the demand of fuelwood, remaining may be diverted to raw material starved wood based industries like paper, panel products and for solid wood utilisation like construction, joinery and furniture and other specialised uses. Studies have been undertaken recently at the Forest

Research Institute to find the suitability of these plantation woods for different industrial uses and to modify the processing techniques and production processes to make them suitable for different industrial uses. The results of these researches have been reviewed in this paper.

पारम्परिक कच्चे माल के विकल्पस्वरूप विगत रोपवनों का औद्योगिक उपयोग

एम० सी० तिवारी व एस० एस० राजपूत

सारांश

काष्ठाधारित उद्योगों के लिए पारम्परिक कच्चे माल का प्रदाय दिन प्रतिदिन घटता जा रहा है। इसकी कमी का समाधान वैकल्पिक कच्चे माल का उपयोग करने में है। देश के विभिन्न भागों में अनेक शीघ्रवर्धी वृक्ष जातियों के रोपवन बड़े पैमाने पर लगाए गए हैं। इन रोपवनों का कुछ भाग आधारतः ईंधनकाष्ठ की मांग पूरी करने के लिए अतिसमुपयोजित किए जा रहे वर्तमान वनों पर पड़े दबाव को कम करने के लिए है, उनके बचे हुए भाग को कागज़, फलकोत्पाद जैसे काष्ठाधारित उद्योगों और भवन निर्माण, बढ़ईगिरी, उपस्कर निर्माण तथा अन्य विशेषित उपयोगों को जिनमें ठोस लकड़ी उपयोग की जाती है, कच्चा माल देने के लिए उपयोग किया जा सकता है जो इस समय उसके लिए तरस रहे हैं। पिछले दिनों वन अनुसंधान संस्थान में रोपवनों की लकड़ियों की विभिन्न औद्योगिक उपयोगों के लिए उपयुक्तता मालूम करने, इनकी विधायन रीतियों तथा निर्माण विधियों में सुधार करने के लिए अध्ययन शुरू कराए गए हैं ताकि इन्हें विभिन्न औद्योगिक उपयोगों के लिए उपयुक्त बनाया जा सके। इन अनुसंधानों के परिणामों की समीक्षा भी इस अभिपत्र में की गई है।

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TABLE 1

Standard specific gravity, modulus of rupture and modulus of elasticity of timber from some recent plantations

Sl. No.	Name of the Species	Locality	Standard specific gravity	Modulus of rupture kg/cm^2	Maximum Crushing stress kg/cm^2
1	2	3	4	5	6
1.	*Acacia tortilis*	Himat Nagar (Gujarat)	0.660	608	344
2.	*Casuarina equisetifolia*	Pauri (Orissa)	0.693	732	327
3.	*Cryptomeria japonica*	Kalimpong (West Bengal)	0.230	270	150
4.	- do -	Darjeeling (West Bengal)	0.229	200	100
5.	- do -	Chakrata (U.P.)	0.302	334	176
6.	*Cupressus torulosa*	Garhwal (U.P.)	0.437	530	278
7.	*Eucalpytus camaldulensis*	Dehra Dun (U.P.)	0.697	621	315
8.	*Eucalyptus camaldulensis*	Gottipura (Karnataka)	0.639	640	288
9.	*E. citriodora*	Ootacamund (Tamil Nadu)	0.647	771	344
10.	-do-	Nigiris (T.N.)	0.742	866	439
11.	*Eucalyptus* sp. (F.R.I. 4)	New Forest (U.P.)		616	299
12.	-do- (F.R.I. 5)	-do-		616	272

(contd.)

1	2	3	4	5	6
13.	*E. tereticornis* (*E.* hybrid) (Nandy variety)	Panchmahal (Gujarat)	0.563	960	288
14.	-do-	Mahakaram (Tamil Nadu)	0.596	510	291
15.	-do-	Devanhally (Karnataka)	0.713	898	402
16.	-do-	Ootacamund (Tamil Nadu)	0.571	817	356
17.	*E. tereticornis*	Ootacamund (Tamil Nadu)	0.694	834	389
18.	*Hevea brasiliensis*	Quilon (Kerala)	0.521	437	200
19.	-do-	Kottayam (Kerala)	0.562	587	331
20.	*Leucaena leucocephala*	Lalkua (U.P.)	0.601	582	297
21.	-do-	Hanumangarh (Rajasthan)	0.578	633	360
22.	-do-	Junagarh (Gujarat)	0.649	806	362
23.	*Maesopsis eminii*	Sakaleshpur & Balehonnur (Karnataka)	0.421	521	254
24.	*Pinus caribaea*	Amarkantak (M.P.)	0.367	347	176
25.	*P. patula*	Pithoragarh (U.P.)	0.311	269	126
26.	*P. kesiya*	Kalenja (Orissa)	0.453	437	210

1	2	3	4	5	6
27.	*Populus deltoides*	-do-	0.419	446	189
28.	Prosopis	*Jodhpur*			
28.	*Prosopis chilensis* (*Syn.P.juliflora*)	Jodhpur (Rajasthan)	0.781	1043	479
29.	*Quercus leucotrichophora* (*Syn.Q.incana*)	Kangra (M.P.)	0.826	788	349

TABLE 2

Suitability indices of timber from some recent plantations

Sl. No.	Name of the species	Strength as a beam	Stiffness as a beam	Suitability as a post	Shockresisting ability	Retension of shape	Shear	Hardness	Refractoriness (splitting coefficult)	Nail & Screw holding power
1	2	3	4	5	6	7	8	9	10	11
1.	*Casuarina equisetifolia*	88	104	86	122	55	127	116	79	117
2.	*Cryptomeria japonica*	30	28	28	30	82	42	20	19	39
3.	*Cupressus torulosa*	71	83	75	53	93	54	55	38	74
4.	*E. camaldulensis*	85	92	84	76*	-	83	99	53	108
5.	*Eucalyptus tereticornis* (E. hybrid)	71	71	72	96*	-	83	96	68	101
6.	*Hevea brasiliensis*	62	77	52	75	-	92	74	75	-
7.	*Maesopsis eminii*	60	63	61	68*	59	58	61	41	67
8.	*Pinus kesiya*	62	64	60	67	72	62	54	38	72
9.	*Prosopis chilensis* (Syn. *P. juliflora*)									
0.	*Q. leucotrichophora* (Syn. *Q. incana*)	98	84	87	107	53	122	155	100	139
1.	*Robinia pseudacacia*	89	86	92	92	-	144	129	103	132

*Tentative

BIOTECHNOLOGY AND FORESTRY

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Introduction

The art of biotechnology is as old as civilization. It encompasses all those industrial processes which are mediated, at one stage or the other, by living organisms. Raising of dough brewing liquors and vinegar, processing tea, coffee, cocoa, tobacco, cheese, making pickeles and curding milk can be traced to times immemorial. Post-renaissance advances in biotechnology include the production of vaccines as prophylactic measures against small-pox and rabies, antidotes against snake venom and tetanus etc. Antibiotics lead the list of post-war achievement in field.

Modern biotechnology is a multidisciplinary field which deals with the practical use of microbial, plant or animal cells to produce goods or perform services for industry, trade and commerce. It is not merely, microbiology, applied biochemistry, biochemical engineering nor genetic engineering, it is a symbiotic integration of aspects of several subjects. Biotechnology is the result of a whole new understanding of life processes that has come into being only in second half of the twentieth century. It encourages the translation of research discoveries into commercial exploitation of inventions- the ultimate objective of all forms of technology. Biotechnology is distined to be " a base for the next industrial revolution". Biotechnology has a very wide spectrum of applications. It can help in the development of methods in different aspects like tissue culture development, microbial culture development, biochemical pathways and mechanisms, growth and enzyme kinetics, genetic manipulations, transport phenomena, reactor design and scale up, process dynamics control and instrumentation, upstream/downstream processing etc. Biotechnology has the capability of providing specific products and processes like antibiotics and related health-care products, foods, feeds, and beverages, fuels and industrial chemicals, industrial enzymes, waste treatment and pollution control, agriculture and forestry applications, mining and metals, diagnostics and biomedical application, biofuels, nitrogen fixation, fermentation, plant hydrocarbons, vaccines, microbial insecticides and biomass production etc. In developed countries biotechnology has been developed at a very fast rate covering a very wider range of aspects. In India the National Biotechnology Board has chosen, genetic engineering,-photosynthesis, tissue culture, enzyme engineering, alcohol fermentation and immunotechnology as areas of immediate interest.

The progress made in biotechnology is revealing for instance it has already been estimated that there are between 50 and 1,00,000 genes in each human cell. When it is finally possible to complete and accurate genetic maps of human and cells of other organisms, genetic engineering based on this sophisticated knowledge could not only fight diseases but could alter the basic characteristics of the organisms. It is true that biotechnology can produce new living models unknown in nature much faster than conventional methods or evolution, but it poses increasingly serious ethical questions.

Application of Biotechnology

Trees have a potential role to play in serving the living beings in many ways but their alarming shortage is being felt at global level. Moreover, billions of seedlings are required to give tree cover to millions of hectares of wasteland. Thus, there is an urgent need to support and protect the trees. To improve their quality and increase quantity if the planet earth is to be saved from destruction. It is in this context that biotechnology can play a significant role. The large size, long life span and complex breeding behaviour of trees have been the main reasons that the scientists have neglected them. It is only through the short-cut efficient techniques like biotechnology which can help in modelling the trees suitable to our needs at a faster rate than the conventional methods like hybridization and propagation through seed etc.

Biotechniques like protoplast fusion (Somatic hybridization), haploidy breeding, polyploidy breeding and mutation breeding coupled with tissue culture can help in releasing the improved planting material quite fast on a mass scale. However, the application of these biotechniques for commercial exploitation needs to be tested.

Biotechnology can help in the following applied aspects of trees:

(1) Production of pure lines through haploids.
(2) Production of triploids.
(3) Somatic hybrids.
(4) Genetic manipulation.
(5) Mass scale production of disease free seedlings from selected or rare trees.
(6) Some clonal variation.

1. *Production of pure lines*

through haploids: Tree species are mostly heterozgous and it is a time consuming process to produce homozygous pure lines through selfing for several generations, but tissue culture techniques can help in their fast production. The first successful report in-vitro formation of *Datura* haploids (Guha and Maheshwari, 1964) has opened a new fruitful field for the production of haploids by tissue culture and doubling their chromosomes to obtain homozygous lines. Extensive use has been made of this methods, especially in China for obtaining superior varieties of several cereals (Zing, 1982). Haploids are also invaluable for mutation programmes. Heterosis can be exploited by crossing two pure lines so produced in trees.

2. *Production ι of triploids:* The report from India on the production of triploids in *Santalum album* by tissue culture is of great interest (Lakshmisita *et al.* 1979). It is known that in *Populus* (Nilsson Ehle, 1936) a natural triploid showed gigantism and since then triploid breeding in trees has been considered profitable. Allotriploids and Allotetraploids have also been produced experimentally in *Eucalyptus tereticornis x E. grandis* (Kapoor and Sharma, 1985) which can be multiplied on a mass scale through tissue culture.

3. *Somatic hybrids:* The standardization of methods for the production of plant protoplasts and their fusion is a development of great promise for plant genetic engineering (Cocking, 1979). The in-vitro production of hybrids of tobacco, petunia (Power *et al.*, 1976) and of tomato and potato (Melchers *et al.*, 1978) by somatic hybridization of protoplasts is one of the most exciting development in this field. These techniques can help in breaking the incompatibility barriers and protoplasts irrespective of species or genus (Carlson *et al.*, 1972) could be fused. Fusion could be tried between teak and eucalyptus,sugar - cane and bamboos and similarly in other species for combining the two different sets of genomes for the production of useful plant types.

4. *Genetic manipulation* : New genes could be introduced through DNA transfer in a tree having superior genes for most of the commercial traits but deficient in one or two like susceptibility to diseases etc. Introduction of nitrogen fixing genes from leguminous species, genes for tolerance to drought, frost,salt, alkali etc. are another theoritical possibilities where biotechniques can show wonders. Thus, there is an urgent need to take up such researches soon.

5. *Mass scale production of disease free identical seedlings from selected or rare trees* : Micropropagation methods are available which can help in multiplying the trees on a mass scale.

These are being applied in developing countries on avery large scale and millions of seedlings are produced in vegetables, fruit trees and ornamentals annually. In India also work is being carried out in many universities, private companies and Institutions for commercial exploitation of these techniques.

Meristem culture can provide disease free plants on a suitable medium having anxins and cytokinings. These plants are generally identical and mutations are relatively.

The culture of callus from the cells of other parts of the tree after initiation to organogenesis can help in selecting strains resistant to diseases,tolerance to frost, drought, salt and alkali due to soma clonal variation available in the culture.

Embroyogenesis is another promising method to produce identical plants from the callus tissue. Though, this method has been found to be applicable to a very few species, such as carrot, but holds promise.

6. *Soma clonal variation* :In test tubes cultures lot of genetic variation has been observed in many species which has been named as some clonal variation. Mutant or polyploid plantlets can be picked up from such cultures which sometimes can be of great significance in improving the tree species genetically. Even physical and chemical mutagens could be utilized in increasing the percentage of some clonal variants where selection pressure could be applied for harvesting beneficial mutants.

Application of Tissue Culture

Forest trees have been regarded as the most interactable for tissue culture propagation. The production of viable teak plantlets from 100 year old teak trees was the first report on the successful propagation of mature forest trees (Gupta *et al.*, 1980) eucalyptus (Gupta *et al.*,1981) Sandal (Lakshmisita *et al.*, 1979, George and Rao,1979), rosewood (Massarenhas *et al.*, 1982, pine (Konar and Singh,1982) have also been multiplied by meristem culture showing a wide applicability of this method (Jaganathan, 1984). Several features of clonal multiplication, which are of importance in forestry deserve emphasis (Jaganathan, 1984):

1. Multiplication of wide range of elites of each species will facilitate improvement of quality, disease resistance etc, and at the same time ensure sufficient genetic diversity to avoid the danger of monoculture.

2. Species which face extinction due to destruction of forest can be preserved by tissue culture.

3. Fast growing eucalyptus trees have been identified, which hold promise of strikingly high yield of fuel and industrial material

which can be multiplied through tissue culture and used as a renewable energy source for rural development and employment.

4. The oil content and composition of *Eucalyptus citriodora* plantlets obtained by tissue culture of mature trees were identical with those of mature trees, whereas the oil of tissue culture plants obtained from seedlings resembled that of juvenile trees (Gupta, 1983). Moreover, teak, eucalyptus and pomegranate plantlets obtained by tissue culture from mature trees were found to flower very early compared to those obtained from seedlings or seed raised plants. These preliminary studies have indicated the possibility of overcoming juvenility in forest trees.

Biotechnology has got a wider scope and application in forestry and needs development of methods and techniques for different tree species. But there is a need of judicious selection of techniques available within the biotechnology and there should be no hesitation in blending it with conventional methods or in selecting the conventional or modern non conventional methods of biotechnology alone in increasing the productivity.

SUMMARY

Biotechnology is a sophisticated and advanced technology encompassing many disciplines of biosciences. It has evolved multidimensional approaches tosolve certain problems at a much faster rate than known to the mankind in the recent past. Biotechnology promises to unfold many events of amazement in the near future, but its use should be with a caution of ethical scense. Tissue culture is one of the biotechniques which has agreat potential for improvement and mass clonal multiplication of forest trees. Micropropagation and embryogenesis can play a significant role in producing identical trees on a mass scale through clonal propagation. Somatic hybridization and haploid production are another areas of interest in forestry. The scope and application of biotechnology in forestry has been highlighted in this paper.

जैव-प्रौद्योगिकी और वन विज्ञान

एम० एल० कपूर

सारांश

जैव-प्रौद्योगिकी एक अत्यधिक परिष्कृत एवं प्रगत प्रौद्योगिकी है जिसमें जैव-विज्ञानों के अनेक विभाग सम्मिलित कर लिए जाते हैं। इसमें कतिपय समस्याओं को इतनी तेज गति से सुलझाने के लिए बहुआयामीय दृष्टियां विकसित की हैं जिनका ज्ञान विगत काल में मानव को कभी ज्ञात ही नहीं हो सकता था। जैव-प्रौद्योगिकी से निकट भविष्य में अनेक चमत्कारी घटनाओं को समझ सकने की आशा की जाती है, परन्तु उनका उपयोग

नैतिक भावनाओं के प्रति ध्यान देते हुए सावधानीपूर्वक किया जाना चाहिए। अतिसंवर्धन एक ऐसी ही जैवप्रविधि है जिसमें वन वृक्षों का बड़े परिमाण पर कृन्तकीय बहुलन कराके उनमें परिष्कार लाने की बड़ी संभावनाएं हैं। कृन्तकीय प्रवर्धन विधि द्वारा एक समान वृक्ष बड़े पैमाने पर उत्पन्न कराने में अणुप्रवर्धन और भ्रूणप्रजनन महत्वपूर्ण भूमिका निभा सकते हैं। तनू प्रसंकरण और अर्धक एक गुण उत्पादन वानिकी की दिलचस्पी के दूसरे क्षेत्र हैं। प्रस्तुत अभिपत्र में वानिकी में जैव-प्रौद्योगिकी के विस्तार-क्षेत्र और प्रयोग के क्षेत्रों पर प्रकाश डाला गया है।

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WOOD PRESERVATION : TECHNOLOGIES FOR THE TWENTY FIRST CENTURY

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Introduction

The fast depleting fossil fuel resources have put increased pressure on forests both for fuel as well as industrial raw material. This phenomenal increase in demand for wood has resulted in denudation of forests at a rate never noticed before. This has changed entire pattern of research and development during the last decade. Where as new uses of wood and woody fibres are being developed, the decreasing forest cover coupled with increased use of man-made material has alarmed the environmentalists, who are foreseeing disastrous results if the level of rising pollution arising out of the manufacture and use of such materials is not checked. Constant efforts are thus being made to develop alternate technologies/materials, which do not add to the pollution level. With the increase in level of pollution, the list of polluting substances also increases. Many substances or chemicals which are today considered as non-pollutant, may be regarded as dangerous in the years to come. Wood preservatives, resins used to manufacture wood based panel products, and even saw dust generated during wood conversion may be declared one day as undesirable. Use of laser beams to saw and convert wood, chemical activation of wood surface to ensure strong and durable bonds and non-toxic methods of preserving wood are being developed as alternate technologies for the future, as substitution of wood is not only impossible, its use is likely to increase because of its renewable nature and low energy investments.

Wood being a readily degradable material of organic origin, the use of wood without adequate protection is uneconomical because of premature failures necessitating early replacement at frequent intervals. Several broad spectrum wood preservatives have been developed during the last few decades to combat these hazards. During this period some of the most effective preservatives were developed. Copper-chrome-arsenic composition developed at Forest Research Institute, Dehradun in 1933 is consumed today to the tune of 70,000 tons on global basis of which 40,000 tons is consumed in the United States alone, (Anon,1985). Such preservatives are based upon toxicity of the chemicals to the various organisms involved. Such chemicals are also toxic to the humans and as such their increased use is viewed with great concern by the environmentalists. Because of their long term efficacy they can continue to have residual effects in the environment when discarded wood is finally disposed off. Hazards also exist at the chemical plants where these chemicals are manufactured.

Because of increasing level of pollution from other sources, efforts are being made to control the same from all possible angles. The policy on use of various chemicals posing pollution hazards is constantly reviewed by various agencies in several countries. The use of arsenic containing preservatives has been restricted in three European countries Willeitner, 1976).The Product Control Board in Sweden has banned the use of pentachlorophenol, a most widely used preservative the world over (Richardson,1977). The U.S. Occupational Safety & Health Administration (OSHA) has no doubt cleared the use of arsenic containing compounds, since pentavalent arsenic has been found to be non-hazardous. However, this clearance may be revoked any time as pentavalent arsenic is manufactured from trivalent arsenic which is highly toxic. Chromium may be the next casuality as the same is an established carcinogenic chemical. With such ban, the use of most effective wood preservatives like Copper-Chrome-arsenic, Copper-Chrome-boron, Acid-copper-boron is likely to be adversely affected. Insecticides based on chlorinated hydrocarbons are being slowly phased out because of their long term residual and cumulative effect. Pentachlorophenol and creosotes are already on the hit list because of their toxicity, odour, or colour considerations. Such ban will be highly deleterious to the use of wood. Since the use of wood has to continue because of several advantage such as ease and low cost in processing, high strength combined with light weight, aesthetically pleasing and above all renewable nature, efforts are being made to develop non-toxic methods of preserving wood. Such methods are based on chemical modification reactions which alter the nature of wood making it unrecognisable and unpalatable to wood degrading organisms. The non-toxic approach to preservation of wood is an intriguing futuristic research concept having great commercial potential and far fetched technological advantages, as wood so treated not only becomes resistant to biodegradation but also improves in dimensional stability, density, mechanical strength. This subject has attained so much importance that there may be over 70 research groups around the world involved at present on studies on wood modification reactions.

Chemical modification techniques

Chemical modification of wood is defined as a chemical reaction between some reactive parts of wood with chemicals which can form stable covalent bonds. Themost abundant reactive chemical sites available in wood are the hydroxyl groups, present on all major wood components. Most biodegrading organisms forge link with wood through these hydroxyl groups as these sites meet the specific requirement for the enzyme-substrate reactions. Blockade of these hydroxyls deprives the enzymes secreted by degrading organisms to act upon wood. The hydroxyl groups also act as sites for adsorption of water causing wood to swell and shrink in contact with water or changing relative humidity. Such cyclic changes can cause physical deterioration such as checking, splitting resulting in mechanical degradation and opening new wood surfaces for fungal and insect attack. Chemical modification thus helps in protection of wood in two ways (i) denying sites for micro-rganism to settle (ii) preventing physical degradation thus protecting the interior untreated portions.

Chemical modification achieved through substitution of hydroxyl groups can be divided into three types of reactions i.e. (i) acetals (ii) ethers (iii) esters. The comparative performance of these reactions vis-a-vis wood protection is listed in Table 1.

Among all the reactions so far studied, reactions with epoxides and acetylating agents appear to be the most promising. As such detailed investigations have been carried out on these two processes.

(i) *Reactions with Epoxides:* Forest Products Laboratory Madison (U.S.A.) initiated work on reaction of wood with propylene and butylene oxides in 1975 (Rowell and Ellis, 1984). Low molecular weight epoxides were found to have advantage in penetrating the cell wall and react with wood at faster rate. The reactions proceed well in presence of mild alkali such as triethylamine as catalyst and the chemical bonds formed are very stable. Weight per cent gains between 20-35 per cent could be obtained in a reasonably short period varying between 40 minutes to 6 hours in various wood species studied. At such weight per cent gains, the wood developed resistance to brown rot and white rot fungi, termites and marine organisms. Such wood is weather resistant having 50 to 70 per cent dimensional stability and is relatively less flammable (Rowell *et al*, 1984). Treatment with epoxides, however resulted inloss in strength properties between 7 to9 per cent. Treatment with epoxides has to be carefully handled as propylene oxide and

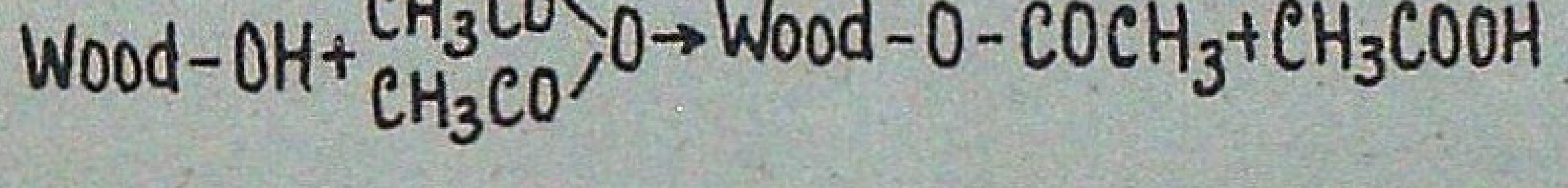
Table - 1

Bond Type 1	Chemicals Used 2	Efficacy 3	Disadvantage 4
Acetal	Formaldehyde	(i) Good decay resistance at low levels (2-5 WPG) (ii) Good dimensional stability at 3-7 WPG	(i) Smell due to excess of formaldehyde (not easily removable) (ii) Mechanical properties reduced hydrolysis of cellulose (long term strength loss)
Ether	(i) Acrylonitrile	(i) Good decay resistance at 17-20 WPG (ii) Good Dimensional stability	(i) Chemical toxic. (ii) Higher treatment levels needed due to polymerization high costs.
(ii) Epoxides	(ii) Epoxides	(i) Good Decay resistance at 20-25 WPG (ii) Good Dimensional stability 20-25 WPG	(i) High treatment levels needed due to polymersation. (ii) Chemicals are highly flammable. (iii) Loss in mechanical strength and explosive.
Ester	(i) Acetic Anhydride	(i) Good Decay resistance at 17-20 WPG (ii) Good dimensional stability at 15-20 WPG (iii) Non toxic chemicals	(i) High chemical cost as 50 percent lost as by product. (ii) Acetic acid produced resulting in smell, corrosin of metal and hydrolysis of cellulose (long term strength loss)

1	2	3	4
	(ii) Isocyanates	(i) Decay resistance stability at 20-25 WPG (ii) Good dimensional stability at 20-25 WPG	(i) Toxic chemical. (ii) Higher treatment levels needed due to polymerisation. (iii) Mechanical properties reduced.
	(iii) Thioacetic acid	(i) Good biological resistance around 12 WPG	(i) Wood continues to emit smell of H_2 s., if entrapped thioacetic acid is not removed.
		(ii) Good dimensional stability at (iii) Improved strength (iv) Non toxic chemicals (v) No colour change in treated wood.	(ii) Prolonged contact with reagent results in reduced gains in physical and machanical properties.

butylene oxide are flammable and may pose fire hazards, during treatment. Moreover, these compounds being polymerisable, part of the chemicals are bound to be lost in the cell lumen of wood without adding any favourable properties to the wood. High levels of chemicals going into the cell wall have been observed to cause superswelling resulting in cell wall rupture. All these factors require very precise controls during treatment of wood with epoxides.

(ii) *Acetylation :* Acetylation of wood is perhaps the oldest modification process conceived in 1928. The first patent on wood acetylation was obtained in 1930 using acetyl chloride (Suida,1930). Acetylation with acetic anhydride is, however, the most studied reaction since the first patent on this reaction was obtained (Ridgway & Wallington, 1946). Although several catalysts were investigated to optimise the parameters for this reaction, uncatalysed acetic anhydride diluted in Xylene at 100-130° C provided the best reaction condition (Goldstein, *et al,* 1961). Reaction with acetic anhydride proceeds as follows :



$$\text{Wood-OH} + \begin{matrix} CH_3CO \\ CH_3CO \end{matrix}\!\!>\!O \rightarrow \text{Wood-O-}COCH_3 + CH_3COOH$$

Over 50% of the reagent in this reaction is converted into acetic acid which is entrapped in the wood. The entrapped acetic acid continues to emit smell and is a constant danger to metallic fasteners and fttings as well as degradation of cellulose chain resulting in corrosion and degradation in mechanical strength. Presence of acetic acid may also reverse the reaction by hydrolysing the esters bonds. Attempts have, therefore,been made to recover the unreacted reagents and the by products but high costs have been the bottlenecks for commercialisation of these techniques.

Studies have been going on since 1979 in Wood Preservation Branch of Forest Research Institute & Colleges, Dehradun on a alternate acetylating reagent (Singh *et al,* 1979). Thioacetic acid is such a reagent which readily reacts with wood and does not produce any by-product harmful to wood. The reaction proceeds as follows.

$$\text{Wood-OH} + CH_3COSH = \text{Wood-O-OC-}CH_3 + H_2S$$

Reaction has been found to proceed well in vapour phase at 93° C± 1 (Boiling point of CH_3 COSH). Whereas presence of moisture has been found to adversely effect reactions with acetic anhydride, moisture content upto 7-8% have been found to have no adverse effect in case of thioacetic acid.

The hydrogen sulphide gas liberated during the reaction does not affect the wood adversely and escapes. To prevent pollution of the atmosphere, the H_2S gas is recycled through a mixture of acetic anhydride and pyridine to produce thioacetic acid for reuse. Some thioacetic acid however, remains entrapped in the wood which is likely to adversely affect the wood properties such as strength (as thioacetic acid is a solvent for lignin). The treated wood also continues to smell of thioacetic acid if not completely ridden off the same. Unreacted thioacetic acid is, however, easily removed by Xylene extraction which has been found not to affect the modification reaction and the resultant wood properties (Kumar & Kohli, 1985).

Properties of Wood Acetylated with Thioacetic Acid.

Acetylated wood has been found to possess unique properties such as decay resistance, termite resistance and dimensional stability.

Thioacetic acid has been found to have an edge over acetic anhydride in producing a better product at much lower reaction levels. Table-2 lists comparison of properties of wood acetylated with acetic anhydride and thioacetic acid. Wood acetylated with acetic anhydride in the presence of pyridine catalyst develops dark colour, whereas acetylation with thioacetic acid did not alter colour or texture of wood. Weight per cent gain obtained without catalyst in case of wood acetylated with acetic anhydride is 15-20 and in case of wood acetylated with thioacetic acid is 8-17. There is marginal density increase even at higher WPG in wood acetylated with acetic anhydride but there is considerable density increase even at low levels of WPG (7-8) in wood acetylated with thioacetic acid. Although in normal wood, shrinkage has been found to increase with density, increase in density during acetylation has no adverse effect on shrinkage. In fact shrinkage has been found to decrease due to bulking of cell wall and acetylation with thioacetic has been found to be more advantageous in reducing shrinkage.

Although higher weight per cent gains are not possible in acetylation with thioacetic acid in the absence of a catalyst, wood acetylated with thioacetic acid develops immunity to rot and termites at much lower weight per cent gains. For example even at a WPG of 8%, weight loss in termite tests is only 10%. At such weight per cent gains, weight loss in fungal decay tests are also around 10%. Such behaviour may be attributed to a different pattern of substitution in different components of wood.

In strength properties, acetylation with thioacetic acid does not apparently appear to have any edge over acetic anhydride. Despite increase in density of wood, the increase in strength is only nominal. This could probably result from the fact that thioacetic acid is a known solvent for lignin & probably results in loosening of lignin-hemicellulose-cellulose

Table - 2.

Properties of acetylated wood	Acetylation with acetic anhydride	Acetylation with thioacetic acid
Colour	Black/dark colour of pyridine catalyst	No colour
Weight percent gain obtainable without cataktst.	15-20 WPG **	8-17 WPG
Density increase%	Nominal at 20-22% acetyle content*	3.9 at 7-8 WPG
Decay resistance	Resistance at 16-17 WPG***	Good decay resistance at 18 WPG.+
Termite resistance	Termite resistance at 18 WPG.**	Termite resistance at 12.8 WPG.+
Antishrink efficiency	42% at 15% acetyle content*	60% at 8.7 WPG.+
Mechanical Strength		
(a) Bending	Increase by 20%++	Increase by 3-47% in hardwoods & 1.5% in softwood.+++
(b) Comoression	Increase by 6-39%++	Increase by 5.6 7.1% in softwoods and increase by 3.2 to 24.26% in hardwoods.+++
(c) Toughness	Increase by 30%++	Increase by 10 to 23% in softwood and increase by 6 to 49%.+++

* Tarkow, Stamm and Erickson, 1950 ** Goldstein, *et al* 1961
*** Peterson and Thomas 1978 ± Kumar and Agarwal, 1982
++Dreher *et al*, 1964 +++ Agarwal,Kohli, Shukla and Kumar, 1985.

bonds. This is also apparent from the fact that prolonged treatment periods beyond three hours result in fall in most of the strength properties.

Bottlenecks for using Thioacetic Acid

There are some disadvantages of using thioacetic acid for acetylation of wood.Preparation of thioacetic acid requires very precise cnditions. This however, cannot be a bottle-neck as with present level of technology the parameters can be very easily controlled in a chemical plant. Thioacetic acid has a disagreeable smell so conditions at the treatment plant will have to be controlled properly. Prolonged contact of thioacetic acid with wood will have to be avoided to get optimum results. This may require finding out a suitable catalyst so that maximum weight percent gains are obtainable in the minimum possible time.

Conclusions

Effectiveness at alower weight percent gains, makes acetylation with thioacetic acid an attractive process. Since the acetylated wood becomes immune to changing humidity conditions and attains a high degree of dimensional stability, it may not be necessary to obtain thorough penetration of the treatment in thicker sections, as the outer treated shell will continue to provide protection against moisture penetration, fungal, borer and termite attack. The process will be most suited for treatment of finished products. Treatment does not require any additional preparatory step except drying to 7-8% moisture content which is a normal practice in wood utilisation.The process thus offers an economically viable non-polluting alternative (having far fetched gains) to the present day preservation techniques based on toxicity.

SUMMARY

Rising levels of atmospheric pollution have been responsible for imposition of restrictions on use of persistent type insecticides and toxic chemicals. Some of the most effective wood preservatives are likely to be phased out by the turn of century. Since preservation of wood has to continue, new techniques involving use of non-toxic chemicals are being developed arond the world.

This paper compares the performance and suitability of acetylation process developed by Wood Preservation Branch using thioacetic acid, with other processes using other reagents. The process compares well and has an edge over other processes being more effective against fungal and termite attack, improvement in dimensional stability and mechanical strength.

काष्ठ परिरक्षण–इक्कीसवीं शताब्दी के लिए प्रौद्योगिकियां

कामिनी कोहली व सतीश कुमार

सारांश

निरन्तर बने रहने वाले कीटनाशी और मादक रसायन पदार्थों के उपयोग पर वातावरण में प्रदूषण की मात्रा अधिक बढ़ जाने के कारण प्रतिबंध लगाना पड़ा है। कतिपय अत्यधिक प्रभावशाली काष्ठपरिरक्षी शायद वर्तमान शताब्दी समाप्त होते-होते क्षेत्र बाहर हो जायेंगे। परन्तु काष्ठ को परिरक्षित करते रहना ही होगा इसलिए दुनियाँ में सर्वत्र गैर विषैले रसायन पदार्थ उपयोग करते हुए नई प्रविधियों का विकास किया जा रहा है।

इस अभिपत्र में काष्ठ परिरक्षण शाखा में थियोएसेटिक अम्ल उपयोग करके विकसित की गई ऐसिटाईलीकरण प्रविधि की तुलना अन्य प्रतिकारकों को उपयोग करने वाली अन्य विधियों से की गई है। यह नई प्रविधि उनके बराबर ही उपयोगी रही है तथा अन्य प्रविधियों से इसमें थोड़ा अतिरिक्त लाभ यह है कि यह दीमक और कवकों के विरुद्ध उनसे अधिक प्रभावकारी है, आयामीय स्थायित्व में परिष्कार लाती है तथा संधारी शक्ति को बढ़ाने वाली है।

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RECENT ADVANCES IN STATISTICAL RESEARCH IN FORESTRY

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Introduction

Forests are no longer an inheritance of the past as once it was believed to be. For the very same reason methods employed in the determination of Forest Growth assumes paramount importance. To decide on an optimal utilisation pattern of forest resources, uniform and efficient methods of assessing forest inventory at convenient intervals of time should be developed. The pressure on natural forest is so much that foresters have now embarked upon a programme of forestry extension to village areas. This is nothing but the well acclaimed Social forestry programme. Again it is a problem thrown before statisticians, how best to assess the impact of these programmes. Forest is not only a source for timber and firewood but also a source for numerous products like honey, lac, resin, bamboo etc. to name a few. Though these come under the category of minor forest products, they contribute substaintially to the public exchequer. Thus there is an urgent need for the identification of suitable sampling strategies for the estimation of these products.

This paper will serve as a review of Statistical Research done in the field of forestry pertaining to areas in sampling, design of experiments, non-parametric methods, stochastic process etc.It further highlights some of the Computer applications in forestry research and management in the light of the introduction of Computer facilities for forestry research in our country.

Study of Forest Growth

The growth of a forest stand may be characterised in a multitude of ways. The recorded changes in the dimensions of the trees as obtained by direct measurements, however refer nearly always to the diameter at breast height. Apart from diameter growth, height growth only may be determined by direct measurements. Growth in basal area and volume has to be inferred indirectly from changes in diameter at breast height and height or from changes in d.b.h. alone. In order to understand the situation clearly, it is helpful to consider a forest stand as a "population" of trees. The individual trees of the population are grouped into diameter classes,the diameter being measured at breast height outside bark. The frequency distribution of a number of trees in terms of d.b.h. characterises a given status of the forest.

As the growth process of trees belonging to different species are different, the exercise is to be carried out for different species separately. It can be seen that the increment of a forest is characterised by the change in the frequency distribution of the number of trees represented in terms of d.b.h. Subsequent changes in total basal area and volume, change in height etc. may be inferred from the changes which occur in diameter as soon as the relations between basal area,volume and height to d.b.h. are known. Now-a-days height of a tree is also measurable with a certain degree of accuracy and hence multiple regression methods are extensively employed in the constructions of volume tables. It is necessary to assume that an established relationship remain the same throughout a period for which the increment is determined. In reality, the relation between volume per tree and diameter and height, may change somewhat while considering the conditions in certain stand. By carrying out a thinning, for example, all the relatively smaller suppressed trees may be cutout. In making increment determinations, it is hardly necessary, however to take this into account. Unavoidable errors of observation and sampling errors overshadow by far such changes in the relationship between various characteristics of a forest stand and the diameter at breast height.

The actual status or structure of a forest changes not only because of the annual growth of the trees but also because trees are removed by cutting or because of natural mortality. In a virgin forest of a balanced structure, the annual growth is practically offset by the annual mortality. Dying trees are continuously being replaced by younger trees and there may exist a perfect balance between growth and mortality. In a managed forest a similar equilibrium is the ultimate goal of sustained yield forestry. Working plan of growth models is the most scientific procedure to tackle the problem. This point will be discussed at a later stage when a discussion on the would be role of computer in Forestry Research will be taken up. The only thing which is intended to be stressed here is that there is still a longway to go in this direction and better scientific statistical procedures are to be developed.

It is generally recognised that variations of the weather influence the annual growth of trees. In temperate climates the effect of changing weather conditions is strikingly revealed in the width of annual rings. Considerable variation in growth also results from causes other than weather. If one is to observe the stump of a tree, a series of wide rings usually follows, denoting the trees vigorous prime, and narrowing rings near the circumference indicate its senescence. In practical as well as in scientific work it is important to know the approximate magnitude of the variations of annual growth that are due to weather. Such a measure is basic to judgement concerning the efficacy of a given silvicultural treatment in a regulated forest. Comparison of periodic growth before and after treatment may be misleading unless the forester has some knowledge of the extent to which fluctuations in weather and climate may influence growth without change of treatment. In other uses of growth measurements the same critical judgement must necessarily be applied. The yield of a managed forest for example might be estimated too high or too low if the increment of the past years, upon which the regulation may largely have been based, was unusually low or unusually high.

Many biological systems exhibit behaviour which are best described by Nonlinear regression models. Forestry is also not an exception to this. Examples of such models in forestry include (a) Simple power function to express tree volume or weight as a function of diameter and height (b) Exponential decay function to express stand density or mortality as a function of stand age and (c) Sigmoidal growth function to express stand diameter, height, basal area or volume as a function of stand age and site index. With the advent of electronic computers the task of dealing with Nonlinear estimation also has been simplified.

Application of Stochastic Processes in the Study of the Growth Dynamics of a stand of trees : (Satyamurthi, 1979)

Forest growth has its own peculiar characteristics which distinguishes it from the general area of Biometrics. Biometrics deals with all "measurement problem" connected with growth of organisms, as individuals or communities. Many of these techniques are not directly applicable to the growth of trees as individuals or as forest stands. A basic problem in this area arises due to the slow growing nature of trees. One cannot start data collection on growth of trees and finish it within a reasonable period of time. Thus more often the researcher is to rely upon data and information which are already collected, though they were not originally collected for studying the growth dynamics of trees.

The growth dynamics of a forest stand of a particular species of trees grown at a given area follow a Stochastic process. This is born out of the following observations. For a given forest stand the frequency distribution in different diameter classes at two different points of time will have different frequency curves. Beta and Weibull distributions are found to give acceptable fits for these diameter values. These were coroborated by studies made by S.K. Seth and Others.

It can be seen that by increasing the d.b.h. class interval in such a way that no tree can grow into the second or higher class intervals (i.e. almost they can grow into the next immediately above class interval within the growing time available) we can get an ideal coincidence between the predicted and observed pattern of growth. The advantage of this finding is that we can use the simple frequency distributions to study the dynamics. This has led to the assumption that the growth dynamics of a forest stand of a particular species of trees follow a simple Markov chain process. That is the trees in diameter class d_i moves in a specified pattern to higher diameter classes irrespective of the fact that the trees in di consists of different age group classes i.e. they have taken different times to reach di. This is a valid assumption because for a homogeneous group if a tree can reach a certain level of growth the potentially for further growth is inbuilt in it irrespective of the earliness or lateness to reach that level. Such a markov chain is described by the initial state and the set of transition probabilities.

The scheme of data collection is to observe randomly selected trees two times, once at time 't' and again at (t+k) time point and keep a record of each tree's two measurements of diameter class signifying movement from time 't' to time 't+k'. This data is utilised to estimate the transition probabilities by the method of maximum likelihood and hence the transformation matrix. This transformation matrix is further extensively employed in predicting the status of a stand of trees at a future point of time. It can further help in estimation problems connected with working plan and forest management.

Non Parametric Methods in Forestry

Study of spatial patterns : The knowledge of the spatial distribution of particular species in a stand of trees is important to the forester specially when it is an endangered species and its preservation is thought of. Moreover for inter regional comparisons they provide adequate material. Satyamurthi has proposed a bivariate index $(\hat{\theta}1,\hat{\theta}2)$ as a summary description of the spatial pattern. It is based on the following observations. In a plane, for patterns formed by points, two types of distances(i) after selecting a random location, the distance at which the nearest point is located (ii) after reaching the said point in (i) which may be called the random point, the distance between random point and the nearest neighbour point to it can be used to calculate two different estimates $\hat{\lambda}_1$ and $\hat{\lambda}_2$. Let $\hat{\lambda}_1$, be the estimate, which gives an idea about the density of clusters arrived at by using the distances as measured in (i) and $\hat{\lambda}_2$ be the second estimate, which gives an idea about the density within the clusters, arrived at by using mainly the distances asmeasured in (ii).For a uniform Poisson pattern we have $\hat{\lambda}_1 = \hat{\lambda}_2$, for an aggregate pattern $\hat{\lambda}_1 > \hat{\lambda}_2$, and for uniform lattice type of pattern $\hat{\lambda}_1 < \hat{\lambda}_2$. Thus if $\hat{\theta}_1 = \frac{1}{\hat{\lambda}_1}$ and $\hat{\theta}_2 = \frac{1}{\hat{\lambda}_2}$ the bivariate index $(\hat{\theta}_1, \hat{\theta}_2)$ by itself will throw more light than a single condensed density estimate. The theory developed is of much importance to solve the problem posed by Brown and Holgate (1974), namely, whether a particular stand was first planted deliberately and then took a more haphazard appearance through a process of random thinning and reseeding or whether it was selfsown and had lost some of its Poisson characters through competition.

Some basic considerations in designing of forest experiments

It is now fairly accepted that increase in production from forest area may be achieved through scientific forest management by improving the Genetic potential or enhancing the site productivity or a wise utilisation of the available forest area or by a combination of the above methods. Thus the influence of spacing and thinning practices and other silvicultural practices on forest production has naturally attracted the attention of forest research workers. This has further necessitated proper designing of field experiments capable of furnishing statistically acceptable results for practical use in the scientific management of the forests.

Some of the basic problems in adopting standard designs for forestry experiments are highlighted here. Take for example a spacing or thinning experiment. Usually a Randomised Block Design or a Latin Square Design with varying spacing allotted with appropriate randomness may be laidout. However, in spacing trials these designs have certain disadvantages which in most cases appear to be of very serious consequence. For example, if different spacing corresponding to different densities are tried in a square or triangular pattern then, essentially there are two possibilities. We may retain constant number of plants per plot, in which case, the size of the plots in the design will be different for different spacings. On the other hand, we may keep the size of the plots constant in which case the number of plants for various treatments will vary.

Apart from the difficulties listed above it has to be stressed that mortality of plants, which is fairly common and sometimes heavy in tree species, will completely alter the spacing treatments in the plots.

Forestry experiments conducted in compact blocks appear to indicate that the major source of experimental variation lies in plant variation rather than with soil variation.This may be observed from the high amount of standard error per plant in different blocks. Thus the randomisations of plants appear to be relatively of greater importance than randomisation in the allotment of treatments to plots. It may also be preferable to try different spacing which are varying more or less gradually within the range of values of interest, say diameter or height, than by big jumps.

Moreover with a view to obtain valid conclusions inspite of mortalities of trees, in the experiment, individual trees may have to be taken as the unit of observation rather than plots containing a number of trees. Lastly, in order to enable the plants to be placed in the correct positions according to the suggested design, the planting positions should have a certain amount of regularity or pattern which could be conveniently determined in the field.

Thus the statisticians should try to give the research worker a design which fits the particular situation, resorting to slight deviations if required depending on the constraints of the situation in the field.

Some of the common designs that are being used in forestry experiments are Completely Randomised Design, Randomised Block Design, Factorial Designs, Split-plot Design and Incomplete Block Design. Partially Balanced Incomplete Block Designs were found to be of great use in Timber Engineering experiments.

Sampling in Forestry Surveys

The object of all forest inventories is to describe quantitatively populations in such a manner that the results are practically useful for purposes of forest management planning, execution and control. In all forest inventories the sampling frame is one or more of the following basic systems of selection:

(a) Simple random layout of sampling units.
(b) Restricted random layout of sampling units.
(c) Layout of sampling units in clusters or
(d) Systematic layout of sampling units.

The choice between these different systems of selection depends on a variety of factors. The sampling technique to be adopted in a forest inventory varies not only with the purpose or object of the survey but also with the kind of timber and forest produce and the topography of the region as well. For overall planning and development of forestry in general the survey results may be required according to forest administrative units, involving fairly extensive areas. For intensive management and exploitation of valuable timber species information is needed for small tracts as well. The intensity of enumeration and techniques recommended may differ accordingly.

There are certain other crucial factors that influence the selection of a particular sampling design. The accessibility of the sampling units is one such consideration. This is the major hurdle in using simple random sampling for forestry surveys. Cluster sampling procedures are also not adopted for the very same reason.

Thus the important sampling schemes which can be considered for forest surveys are

(i) Stratified random sampling and
(ii) Systematic strip sampling.

Out of these systematic sampling has got certain definite advantages over stratified random sampling. It can be seen that systematic sample plots laid in a lattice pattern gives in effect a proportional allocation in stratified sampling. Hence the resulting set of sample units can be considered as a self weighing stratified sample. So there is no great advantage in forming strata by grouping homogeneous units in forestry. Moreover in repeated sampling the systematic samples are more efficient than the stratified samples.

The merits and demerits of systematic sampling in forestry are discussed, by Alexis Zinger (1964). He proposes a systematic sample with pps.

"A further alternative, which is discussed here in detail was first proposed by Madow(1949), it involves drawing a systematic sample in such a way that the probablity that any strip will be included in the sample is proportional to its length. Such a sample isslightly less convenient than one of the type discussed by Finney, in that the selected strips though they give good coverage of the whole forest are not regularly spaced, they will be closer together in areas where the strips are long than where they are short. However the method does give unbiased estimates and is much more convenient in practice than that of Schumacher and Champion, in that only complete strips are sampled".

The systematic sampling is less precise when the distance between plots refers to some periodicity in the material. But such a periodic behaviour in forest surveys is very rare. Another point that is raised against systematic sampling is that a systematic sample cannot by itself provide an unbiased estimate of error variances. But under certain assumptions concerning the pattern of spatial variation about the population one can get a reasonably good estimate of error (Manfred Naslund)

Very recently KIRK M.WOLTER (1980) has studied the problem of variance estimation in systematic sampling. He considered 8 different types of estimators and compared their efficiency under emperical population and super population models. He has further given some guidelines for the selection of the most efficient one depending on the exhaustive apriori information about the population.

Jeff WU (1984) considered the same problem by drawing a supplementary sample from the population by SRS and systematic sampling for providing unbiased estimators of variance.

Another approach for the estimation of basal area of trees which is applicable only in forestry is the point sampling procedure. It was Dr. Bitterlich (1984) who suggested this procedure using a Relaskop or a wedge prism. Dr. Satyamurthi (1983) suggested an improvement in this by using a rope instead of a Relaskop for arriving at the number of tallied trees.

The classical approach to large area forest Inventory by the use of various sampling schemes is slowly becoming reduntant with the availability of far more fast and efficient scientific techniques. They are the techniques of Aerial and photo-interpretation, Mapping and remote sensing. Why do we afterall need a forest Inventory ? When we consider the management unit of working circle level, the inventory is primarly of use in determining the annual allowance cut and the extent and the amount of forest growing stock. It is these basic data and other information from the forest that enable forest management planning to proceed. Till early 70's all the information relevant to thiss context have been obtained through ground surveys alone. But ground surveys are tedious, time consuming and costly as far as forests are concerned. Better efficiency in survey and mapping operations can be achieved by using photo interpretation techniques. With the use of aerial photographs, ground work can be reduced to the minimum and the organisation and control of field work can be improved considerably. Another advantage with aerial photographs is that the work can be continued all the year round and even in difficult and inaccessible areas, whereas the ground work is confined to only good weather and to inaccessible areas. The preparation of land use and forest cover type maps with the help of aerial photographs is accurate and quicker. Intensive use of this technique for forest resource surveys in India has started with the establishment of Forest Survey of India.

Techniques of remote sensing using satellite imagery is extensively used now in western countries for forest inventory studies. 'LANDSAT' imagery can be used as a supplement to aerial photography or in place of aerial photography where low resolution data are acceptible. The advent of LANDSAT imagery is most timely, as its incorporation into conventional forest inventories can do much to alleviate current difficiencies and improve future forest inventory statistics. Application of LANDSAT data include large area planning, updating existing inventories to reflect harvesting, forest fires, and new roads, reconnaissance inventories,forest fire management and detection of forest insect and disease damage.

Computer Application in Forestry

The establishment of the National Forest Computer Centre at Forest Research Institute, Dehradun exclusively for the use of Research Workers in forestry and practical foresters can be looked on with considerable optimism. In the foreseeable future evaluation of extensive forest inventory data will be exclusively done by computers. The multitude of inventory methods can never be completely covered by standard programmes. It is therefore indispensable that the forester in-charge of the inventory .knows enough about data processing to warrant understanding and agreement with the programmer and the data processing expert. The forestry survey of India is the primary agency in India who conduct large scale forest inventory surveys and they are extensively using the Computer for their data processing work. The programme package " FOREST INVENTORY DATA PROCESSING SYSTEM" (FIDAPS) facilitates the analysis of large scale data collected from the field and generates the various yield tables. The same set of programs can be utilized for the preliminary data analysis in connection with working plan.

'Simulation' is a technique which can be extensively employed, in the preparation of working plans. Simulation means imitation of real processes by a programmed model with the purpose of gaining understanding of the real process. It provides the option of incorporating the effects of expected management and environmental changes into the allowable cut decision process within a rotation. Thus the various mnagement strategies may be tested with regard to their efficiency. Since these simulations generally require an extraordinary number of computational steps, simulation procedures gained practical importance only after the introduction of modern high speed computers. "Simulation" is indeed "a step toward better forest management", as the title of a publication by E.M. Gould and W.G.O.'Regan (1965) claims.

Besides, computer is being extensively used in the construction of volume tables and sample plot data analysis. 'VOLTAB' is one of the most efficient program finalised on this computer for the production of volume tables. It generates the regression parameters for a total of 15 models (inclusive of unweighted, weighted and transformed models) and selects the best model based on Furnival Index and generates the volume table based on that model. Statistical Branch is also utilising the Computer for their varied analysis, extensively. Many of the multivariate analysis techniques are being used nowadays only because of the availability of computing facilities offered by the computer. However presently the software support for the Computer users in very meagre. For many of the special applications programs are yet to be developed.

SUMMARY

Role of Statistics in the various facets of forestry research and management has been well recognised. This paper highlights some of the recent research work done on problems in forestry where statistical principles and methods have a larger role to play. They may be categorised as (i) studying of forest growth dynamics(ii) Nonparametric applications (iii) design of experiments and (iv) sampling. The applications of computer in forestry research is also highlighted in brief.

वानिकी में सांख्यिकीय अनसुंधान में हुई विगत प्रगतियां

के० पी० उन्नीकृष्णन व ए० के० चौबे

सारांश

वानिकी अनुसंधान और प्रबन्ध के विभिन्न पक्षों में सांख्यिकी की भूमिका को भली-भांति स्वीकार किया जा चुका है। प्रस्तुत अभिपत्र में वानिकी की समस्याओं पर किए गए विगत कुछ अनुसंधानों पर प्रकाश डाला गया है जिनमें सांख्यिकीय सिद्धान्तों और रीतियों की भूमिका बहुत अधिक रहती है। इन्हें इन श्रेणियों में बांटा जा सकता है। १-वन वृद्धि की गतिकी का अध्ययन करना। २-गैर परिमापीय अनुप्रयोग। ३-संपरीक्षणों का आकलपन और ४-न्यादर्शन वानिकी अनुसंधान में संगणित्र के उपयोग पर भी संक्षेप में प्रकाश डाला गया है।

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CONSERVATION OF ORCHIDS IN INDIA

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Introduction

Orchids, the most fascinated of flowers are facing the danger of extinction throughout the world and especially so in the developing countries like India where the deforestation for new housing projects, factory sites, new Agricultural land and excessive timber production destroys the orchids in large number both directly by killing the orchids which grow on different trees or in their undergrowth or by disturbing the micro-climate of the region which is so essential for the growth of orchids. The extinction of the orchid species always coincides with immense human activity, terrestrial orchids getting depleted faster than the epiphytes.

Man's love for the beautiful orchid flower is the other major factor which has lead to its removal in very large number for cultivation and export. It is these unscrupulous and financially motivated collectors who strip the forest naked in order to earn few dollars. The export of native wild orchids is a universal phenomenon, only the modus operandii changes from time to time, and has resulted in the total extinction of the native flora in the vicinity of cities and big towns. It is a well known fact that the transplantation of orchids from one area to another is a very critical process. As a general rule, orchids can withstand transplantation only after the flowering is over. Unfortunately, most of the orchid collectors collect the plant when they are just starting to bloom in order to get good price with the result that a large number of orchids which are transplanted never get established. This however, does not deter the orchid collectors who are again in the forest in the next season to have their pick. Further, orchids dwell in varied habitat and not all the species will do well under cultivation. Some get their share of bad luck during transportaton, fumigation and improper handling at customs with the result that out of a very larged number of wild species collected from the forest, only few survive in the glasshouses. Their future further depends solely on the whim and fancy of the grower which may go on changing.

The orchid due to their

peculiar habit of interdependence on micorrhizal association for seed germination, nutrition, selective pollinators, obligatory cross pollination are more vulnerable to destruction than any other group of plants. In fact whole ecosystem must be preserved for their natural perpetuation.

The widespread distribution of the orchid species in the world makes it more difficult to have a uniform code for the conservation of orchids, as two neighbouring countries may have common orchid flora but different outlook towards conservation. In most of the developing countries, urbanization and cleaning of areas for agriculture go unchecked and basically unplanned. It has been reported that in India in 1970, a million cubic metre of industrial timber and 203 cubic metres of fuel wood were produced from the forest and that by 1990 this combined consumption would increase 300% (Pradhan 1974). This does not include the areas cleared by natives for farming and shifting cultivation (Jhumming).

At one time it was thought that preventing the collection of wild species may do the trick and help in conservation, but this did not help in areas where forest themselves are destroyed. Some countries forbade the export of important orchid species but then the nurserymen created havoc by collecting all sort of species. Enlightened groups in different countries are however now joining together to make plan and guidelines for the conservation of endangered species. The convention on international trade in endangered species of wild flora and fauna, when ratified by different countries will have far reaching effects on world wide conservation of orchids. This would make it compulsory for different countries to deal in only nursery grwon plants.

Present status in India

India has a very high representation of orchids, i.e. about 1600 species, Maheshwari (1976) out of which about 270 species are restricted to Khasia and Jauntea hills, 150 species in western ghats and rest distributed throughout the great mountain chanis of Himalayas, Vindhyas, Satpura range and Chota Nagpur areas etc. In addition to these, large areas in central India, Western and Eastern Ghats, Andaman and Nicobar Island are totally unexplored.

Indian forests are under tremendous pressure due to fast growing population and industrialization, planting of new trees (Timber type) in the old areas does not help much. It takes 40-60 years for various timber trees to mature, while it takes more than 70-80 years for an orchid colony to develop fully with the result that before an orchid colony develops and establishes itself, the forest is harvested again. Deforestation for Agricultural land is another factor for the fast depletion of Indian orchid species. Jhumming or shifting cultivation has been stopped by Government of India but the tribes of Nagaland and Mizoram have ruined the existing populations of *Vanda coerulea* and other *Dendrobium* species, Pradhan (1977).

In India, the emphasis on conservation is very recent and for the fauna only, the animal world enjoys a distinctly favourable position and there is greater concern for animals (Lion, Tiger, Rhino, Deer etc.) than for plants, so much so that a million dollar project has been launched with the financial help from world life to save the Tiger.

Indian Council of Agricultural Research has initiated some steps for the conservation of orchids in India. The guidelines for which were prepared at the meeting of the orchid workers at Shillong in October, 1977 and during the National Symposium on Orchids held at I.I.H.R., Bangalore in 1980. It was decided and recommended to the Government of India that positive steps have to be taken immediately to conserve the orchids wealth. A 100 acre-primary forest area in Lolaygaon about 25 miles of Kalimpong has already been selected to have an orchid sanctuary. Similarly the sites have been selected in Western Ghats, N.E. Himalayas etc. Some of the state Governments have come forward for the protection of orchid wealth and have started to grow orchids on commercial basis. Arunachal Pradesh Government had invited Dr. Kamemoto of Hawaii University for Survey and Consultation. He submitted a very comprehensive report on the development of orchid industry in NEFA region (Kamemoto, 1971). West Bengal Government, Department of forest has also started a commercial orchid project and has declared certain area in Darjeeling district as "Orchid Reserves" from which no orchids can be collected. It is also envisaged that when a forst area is cleared all the orchids should be suitably planted at commercial nurseries or in orchid reserves. Sikkim Government which has more than 550 orchid species followed suit and banned the total collection and export of orchids. In addition to this, the Government of Sikkim has established two beautiful orchid sanctuaries at Deorali and Singtom, under the guidance of the devoted orchid lover Mr. K.C. Pradhan (CCF. Govt. of Sikkim) who is an authority on the orchid flora of Sikkim (Pradhan, 1963). It must be mentioned here that the steps for the conservation of orchids in Sikkim were taken as early as 1900 and the orchids were considered national heritage sinced very beginning, Pradhan (1974).

Conservation

The convention of international trade in Endangered species of wild flora & fauna. (CITES) ratified by India places all species of Orchidaceae under appendix II.

i.e. the trade in all orchid species will be through export permits. Inspite of this a large number of Indian orchid species are smuggled out via Nepal to Europe an other American countries.

Before going into the details of the ways and means of conservation of Indian orchids it is necessary to have the definition of the endangered species as modified by the Smithsonian Institution (Endangered species act of 1973) who are concerned with the endangered flora project at international level.

1. *Threatened species* are those species which are likely to become endangered within the forseable future. These include species described as very rare or depleted. Example of Indian species are *Arachnanthe cathcartii, Coelogyne cristata, Dendrobium chrysotoxum, D. falconeri, D. wardianum, D. nobile, Paphiopedilum fairieanum, P. insigne, P. villosum, Phaius wallichii, Phalaenopsis manii* and *Renenthera imshootiana* etc. Kataki (1976), Hynniewta and Sarkar (1977).

2. *Endangered* species are those species of plants which are in danger of extinction. Existence may be endangered because of the destruction, drastic modification, severe curtailment of habitat or because of the over exploitation, disease predation etc. Plant taxa from very limited area e.g. the type locality only are usually considered endangered. Example of Indian species are *Dendrobium densiflorum, D. formosum, Calanthe masuca, Coelogyne cristata, Cymbidium giganteum, Vanda coerulea* etc. (Table 1 and Fig. 1-10).

3. *Recently extinct* or *Possibly extinct* species are those plants no longer known to exist after repeated search of the type localities. Some species may be extinct in wild but preserved in cultivation in Botanic Gardens or similar facilities. (Example - Indian species. *Paphiopedilum druryi* now extinct in its original habitat Agast-Malai hills.

The conservaiton of orchids is a very complicated issue and the problems are principally social, aesthetic and economic. Smithsonian report on the conservation of endangered species has recommended that "Preservation of endangered and threatened species of plants in their natural habitat should be adopted as the best method of ensuring their survival. Cultivation and artificial propagation of these species is an unsatisfactory alternative to "in situ" perpetuation and should be used only as a last resort when the extinction appears certain, with the purpose of re-establishing the species in natural habitat.

Some of the Indian orchids have totally disappeared from their original localities. Hooker, in his Himalayan Journal in 1954 gives vivid description of the presence of *Vanda coerulea* near an Oak wood in Jowai area (Khasia and Jaintea hills) and states to have collected 7 headloads of this plant for kew Garden. In the 130 year interval there is hardly any plant left of this species in this area (Kataki, 1976), (Rao, 1971). It is on record that in 1884 the first consignment of *Paphiopedilum spicerianum* from India consisted of 40,000 plants and each plant was sold for Rs. 350 and above by the famous orchid firm Veitch & Sons. Similarly, the lady's slipper orchid *Paphiopedilum fairieanum* from Arunachal Pradesh, *P. insigne* and *P. venustum* from Khasia and Jaintea hills, *P. villosum* and *P. hirsutissimum* from Mizoram, *P. druryi* from Agasta Malai hills (South India). *Dendrobium densiflorum, D. farmeri, D. nobile, Arundina graminofolia, Phaius wallichii* etc. have all become rare or extinct from the places where they were in abundance (Table 1). This is also trued of some very less attractive orchids or Botanicals like *Oberonia, Anaectochilus, Goodyera, Habenaria, Cryptochilus, Anthogonium, Risleya, Sirhookera, Cleisocentron* etc. A large number of thesed botanicals are already included in the list of threatened and endangered species, Pradhan U.C. (1977).

Suggested steps for conservation

(a) Monitoring, mapping and a close survey of the Indian species in their natural habitat will furnish the ecological requirements of different species. This will also help in complete indexing of the Indian orchid flora on the basis of which a red data book regarding the endangered an threatenedd species can be worked out.

(b) Creation of permanent biosphere reserves, orchid reserves in areas of high conservation value as has been proposed for Karnataka.

(c) Establishment of orchid sancturies for preservation and regeneration of individual species. It must be pointed out here that grouping of few orchid species at one place does not mean conservation. We have to be very careful in collecting the species on the basis of their ecological patterns and breeding systems.

(d) Prohibiting the collection of wild species by professionals and preparing a code of conduct for collection of very rare species by amateurs, researchers and students etc.

(e) Controlled introduction of rare and endangered species in Botanic gardens, research institutions. These laboratories should have proper facilities for the regeneration of rare species by embryo culture and tissue culture.

(f) Maintenance of germplasm

TABLE - 1

Showing existing status and distribution of some important and endangered Indian Orchid species

Name of the species	Distribution	Status
Arachnanthe cathcartii Benth.	Sikkim, from 3000-6000 ft. in deep shade	Restricted distribution
Calanthe masuca Lindl. (Fig. 1)	Sikkim, Nepal, Western Ghats	At the verge of extinction
Coelogyne cristata Lindl.	Sikkim, Kumaon hill Nepal	Getting rare
Cymbidium tigrunum Par.	Patkoi hills, Assam	At the verge of extinction
C. elegans Lindl.	Kumaon-Khasia hills, Bhutan hills, Sikkim	At the verge of extinction
C. macrorhizon Lindl.	Kumaon, Khasia, Jaintea hills, Sikkim	Restricted Distributon
C. mastersii Griff	Sikkim, Khasia hills	Restricted distribution
Dendrobium aggregatum Roxb. (Fig. 2)	Assam hills, Bhutan	Restricted distribution
Dendrobium barbatulum Lindl. (Fig. 4)	Western Ghats, Travancore, Nilgiris	Restricted distribution
D. crassinode Reichb. (Fig. 4)	Arkakan, Patkoi hills, Assam	Restricted distribution
D. chrysotoxum Lind. (Fig. 5)	Assam, Arakan, Patkoi hills	Restricted distribution
D. densiflorum Wall. (Fig. 6)	Khasia hills, Assam	At the verge of extinction
D. devonianum Paxt.	Nagaland, Assam	At the verge of extinction
D. farmeri Paxt (Fig. 7)	Assam Khasia hills, Andaman	At the verge of extinction
Paphiopedilum druryi Pfitz.	Travancore hills, Calcad hills	Almost extinct

(contd ...)

Name of species	distribution	Status
P. hirsutissimum Pfitz.	Khasia hills, Patkoi hills Mizoram hills	Restricted distribution
P. fairieanum Pfitz	Assam, Arunachal	Restricted distribution
P. insigne	Assam, Khasia & Jaintea hills	Restricted distribution
P. villosum Pfitz	Assam, Mizoram, Lushoi hills	Restricted distribution
P. venustum (Fig. 8)	Khasia and Jaintea hills	Restricted distribution
Phaius wallichii Bl. (Fig. 9)	*Lower Himalayas, Khasia*	Restricted distribution
Phalaenopsis manii (Reichb)	Teesta valley, Assam, Khasia hills	Restricted distribution
Vanda coerulea (Griff. Fig. 10)	Khasia, Jaintea hills	At the verge of extinction

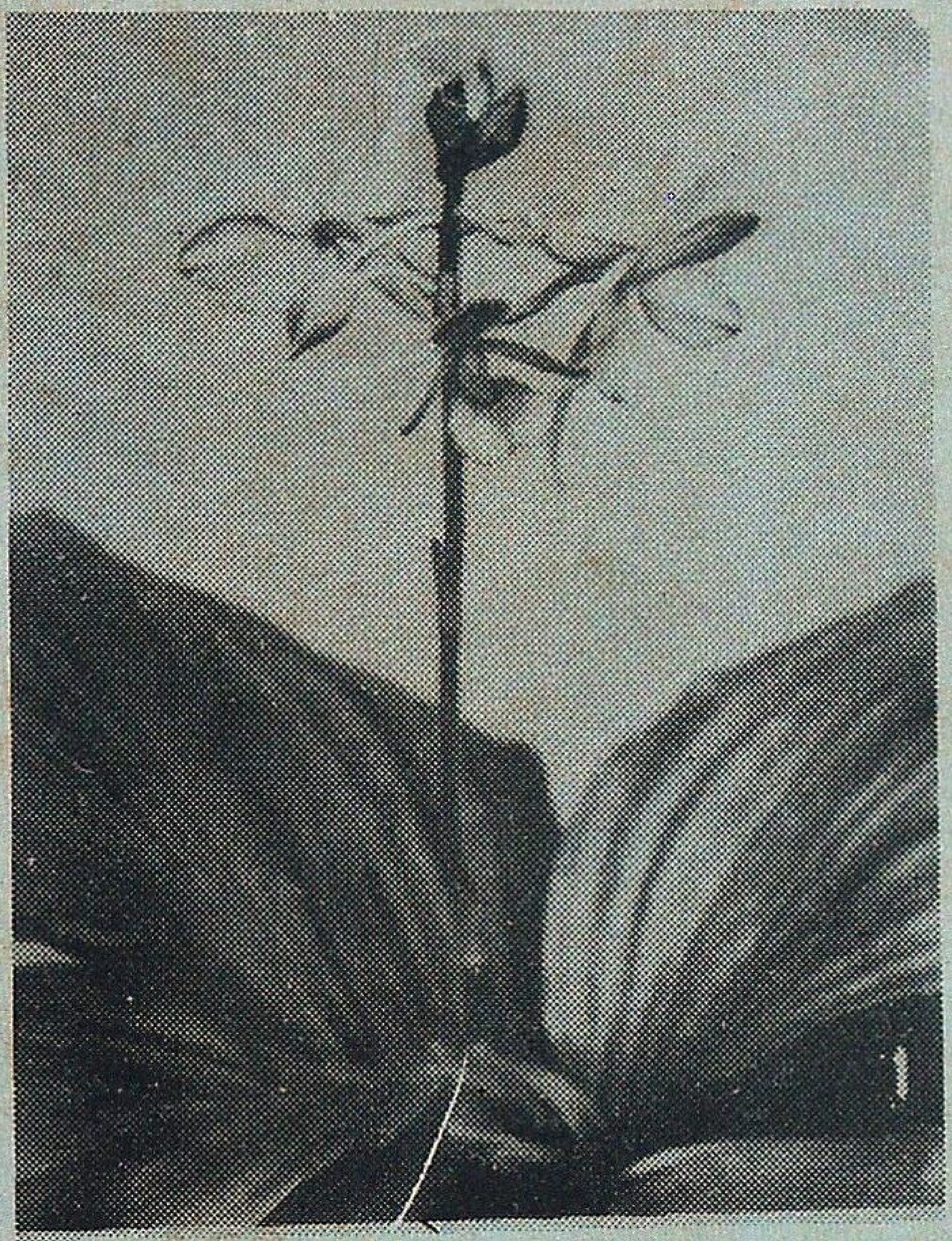

Fig. 1. Calanthe masuca

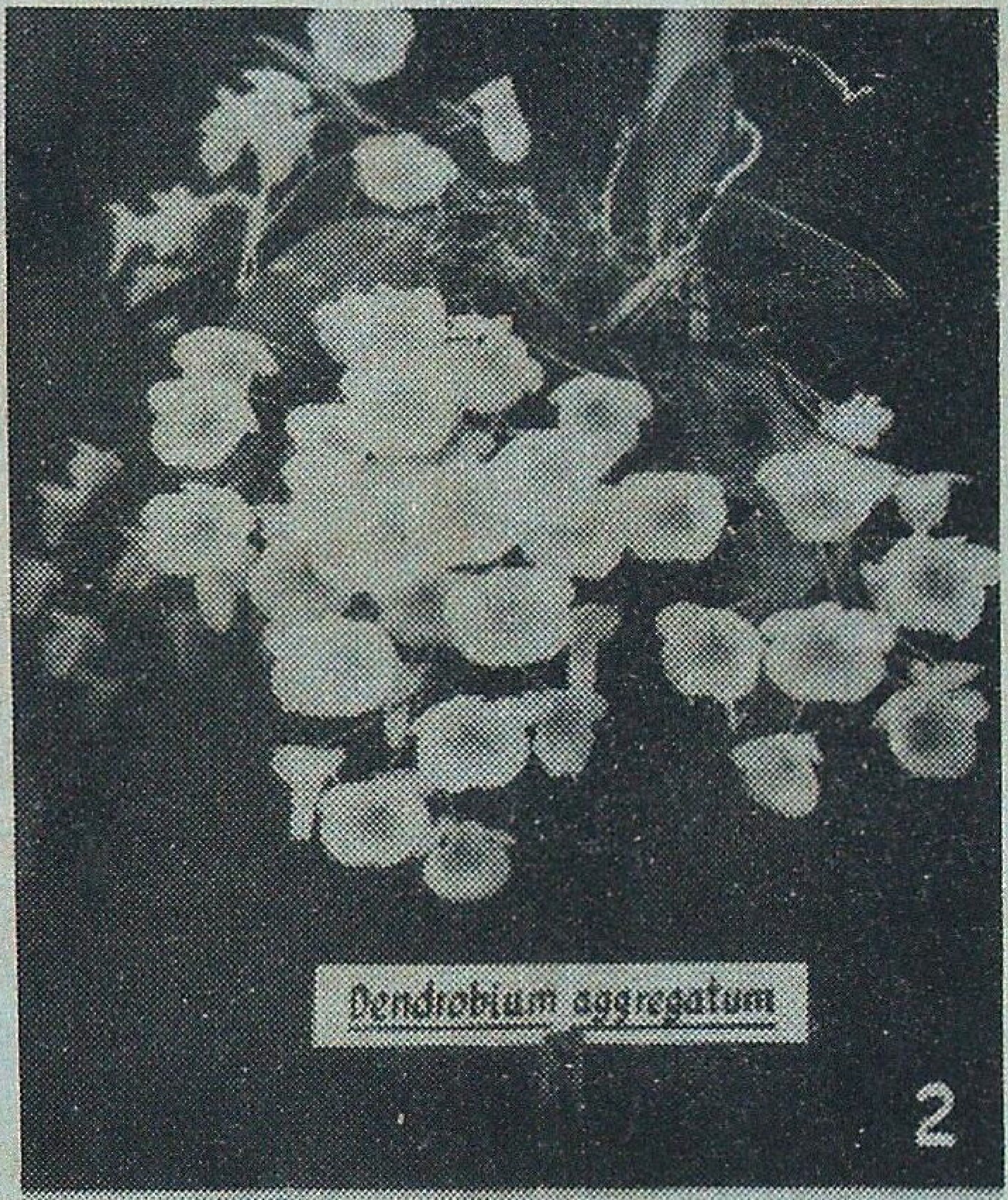
Dendrobium aggregatum
2

Fig. 2. Dendrobium aggregatum

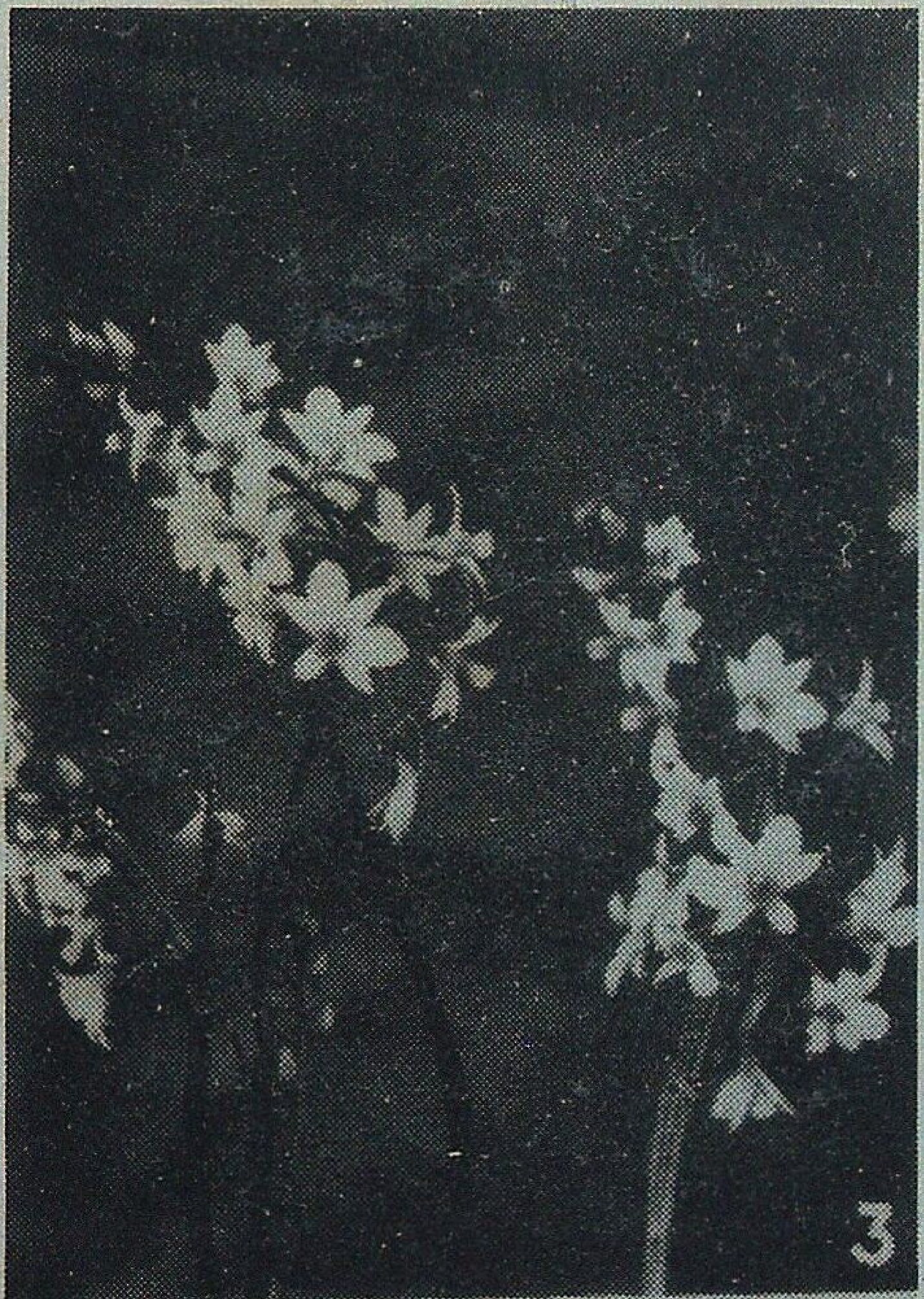

Fig. 3. Dendrobium barbatulum

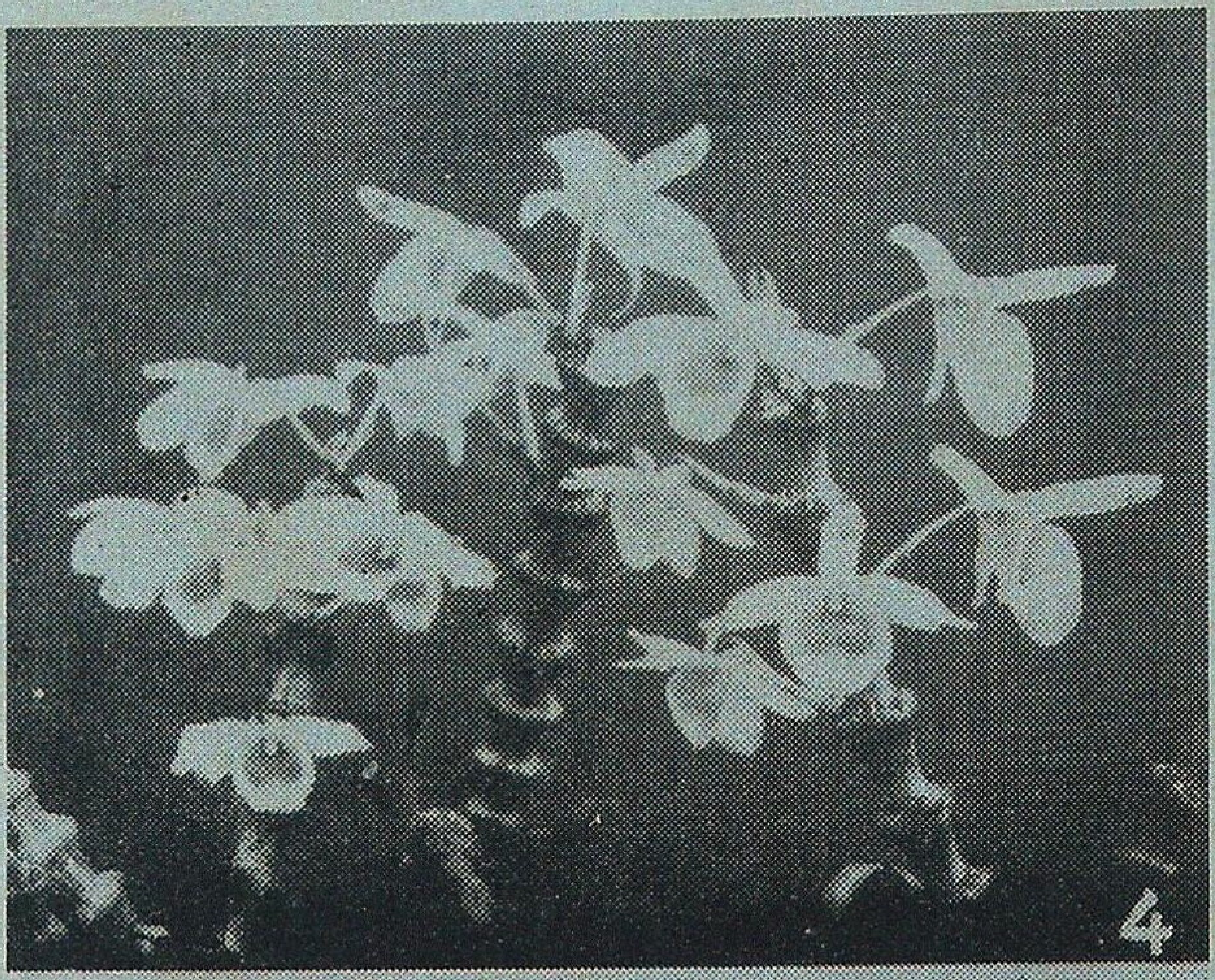

Fig. 4. Dendrobium crassinode

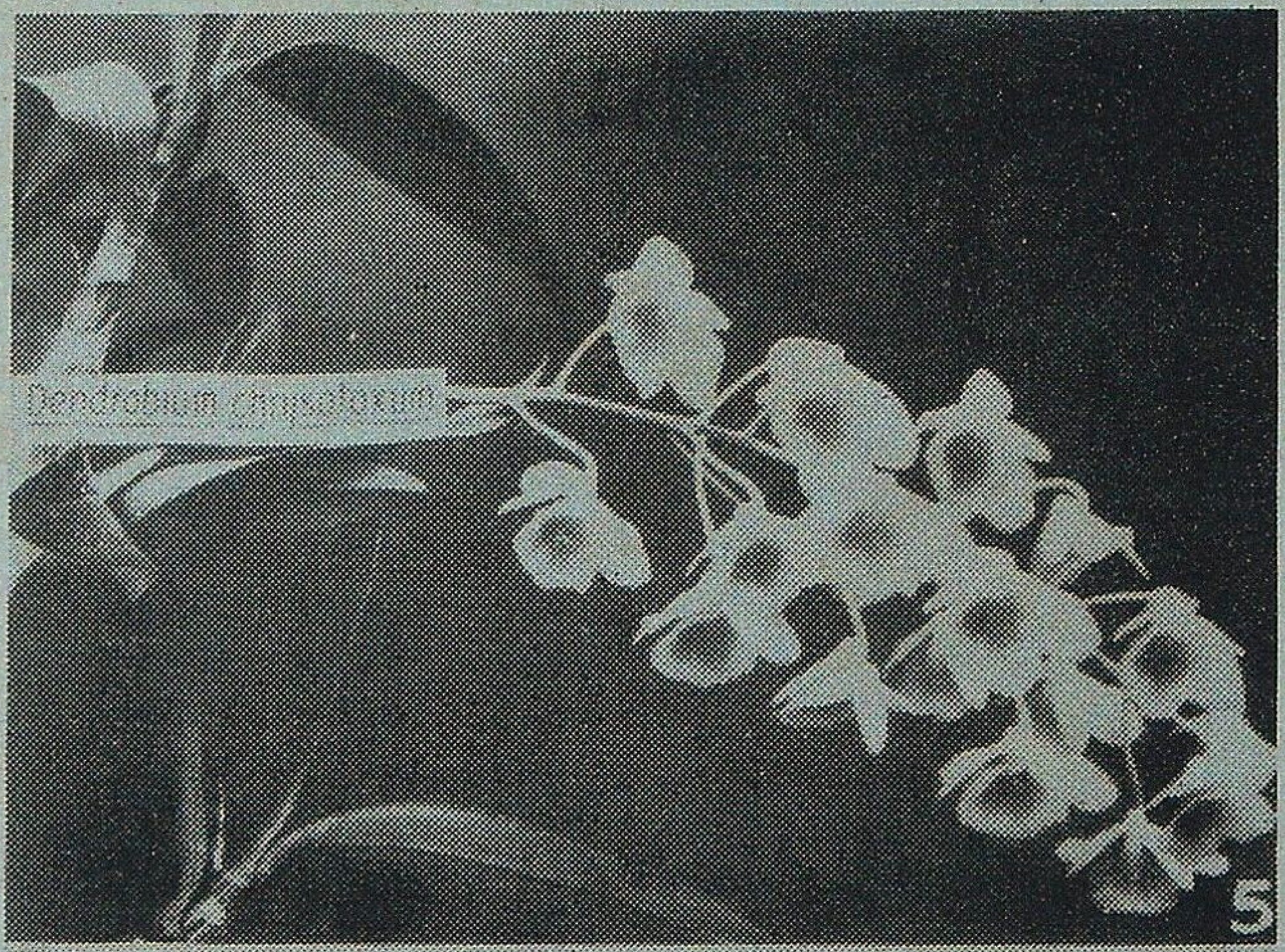
Dendrobium chrysotoxum
5

Fig. 5. Dendrobium chrysotoxum

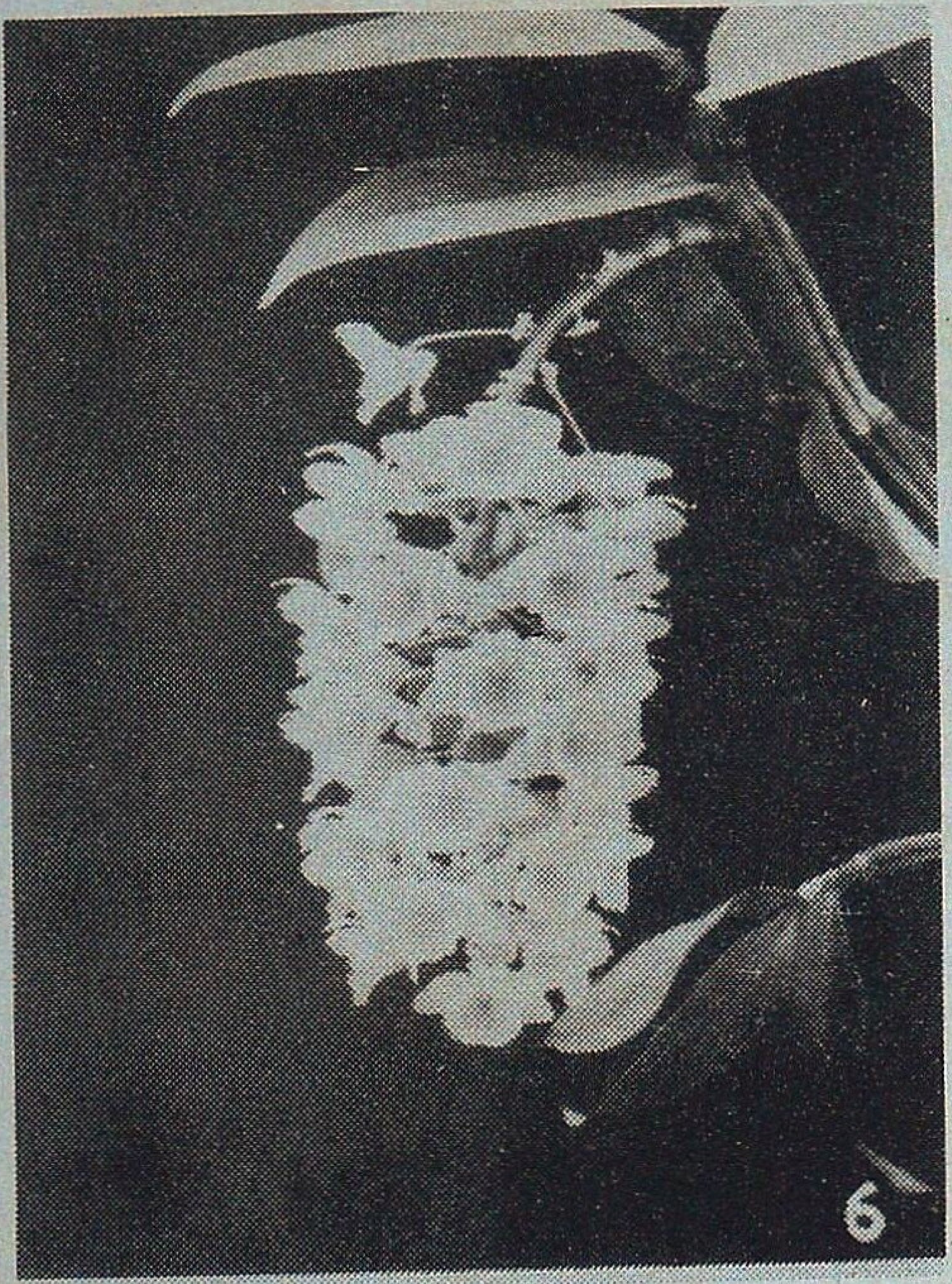

Fig. 6. Dendrobium densiflorum

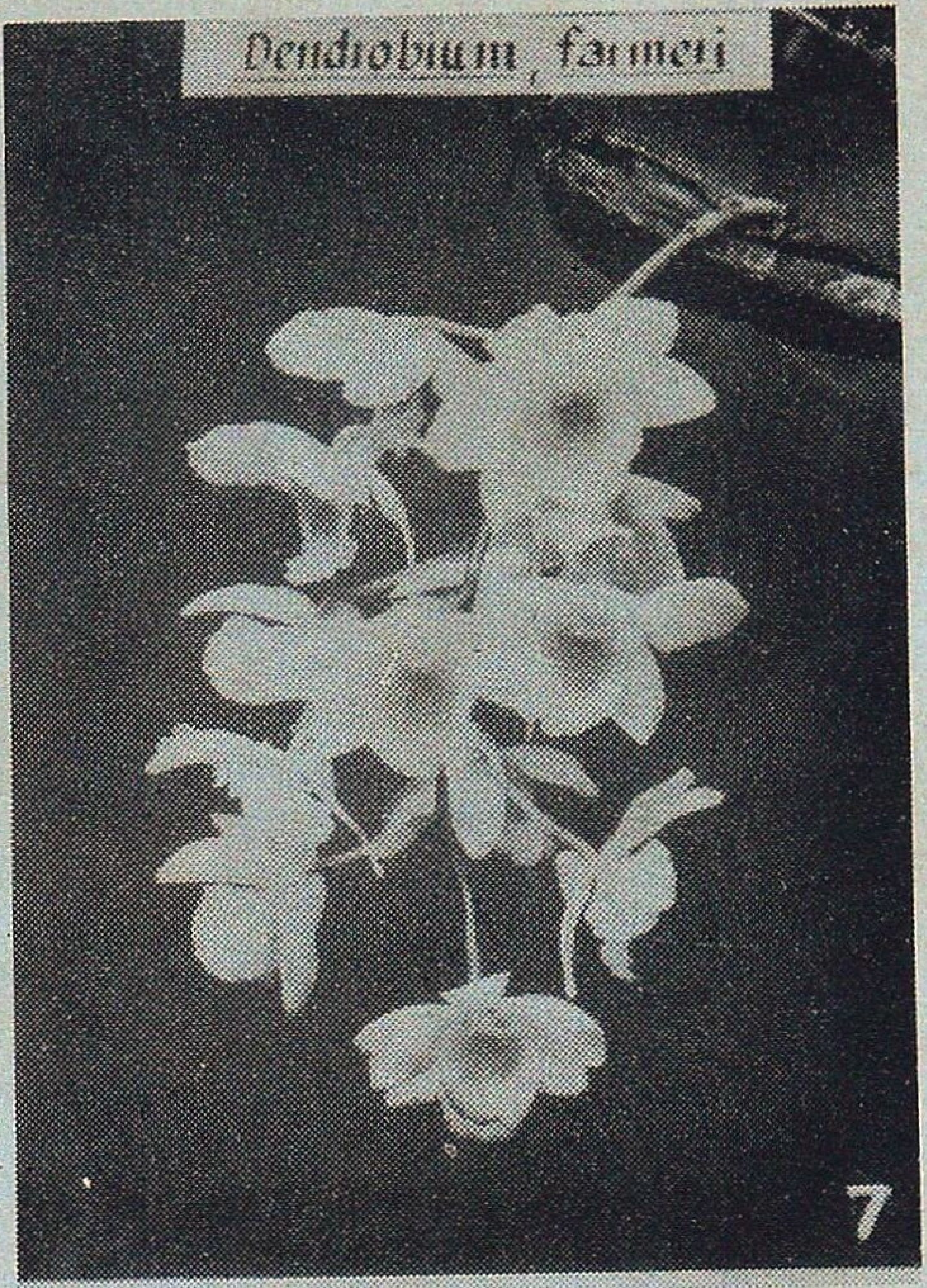
Dendrobium, farmeri
7

Fig. 7. Dendrobium farmeri

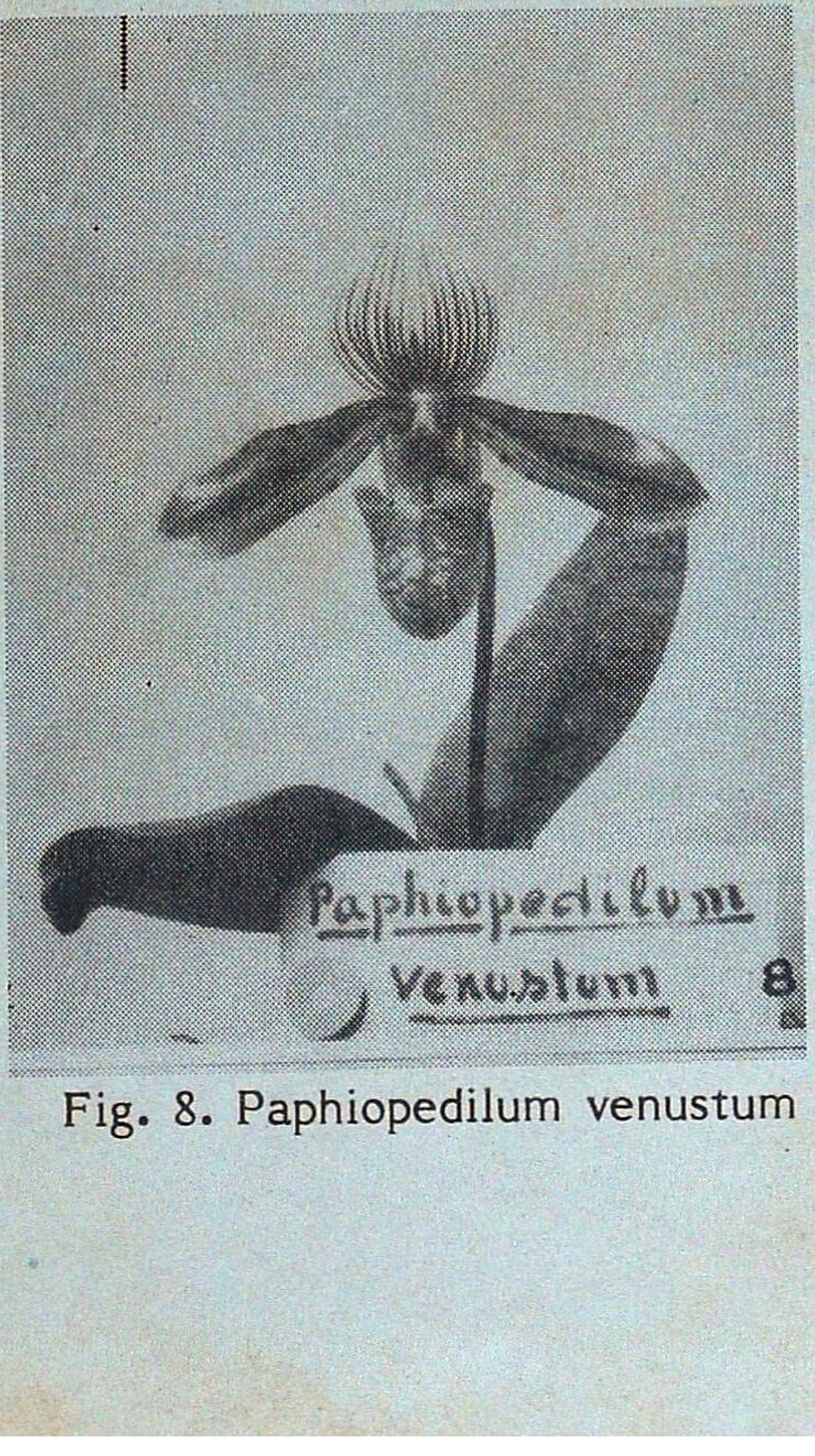
Paphiopedilum
venustum
8

Fig. 8. Paphiopedilum venustum

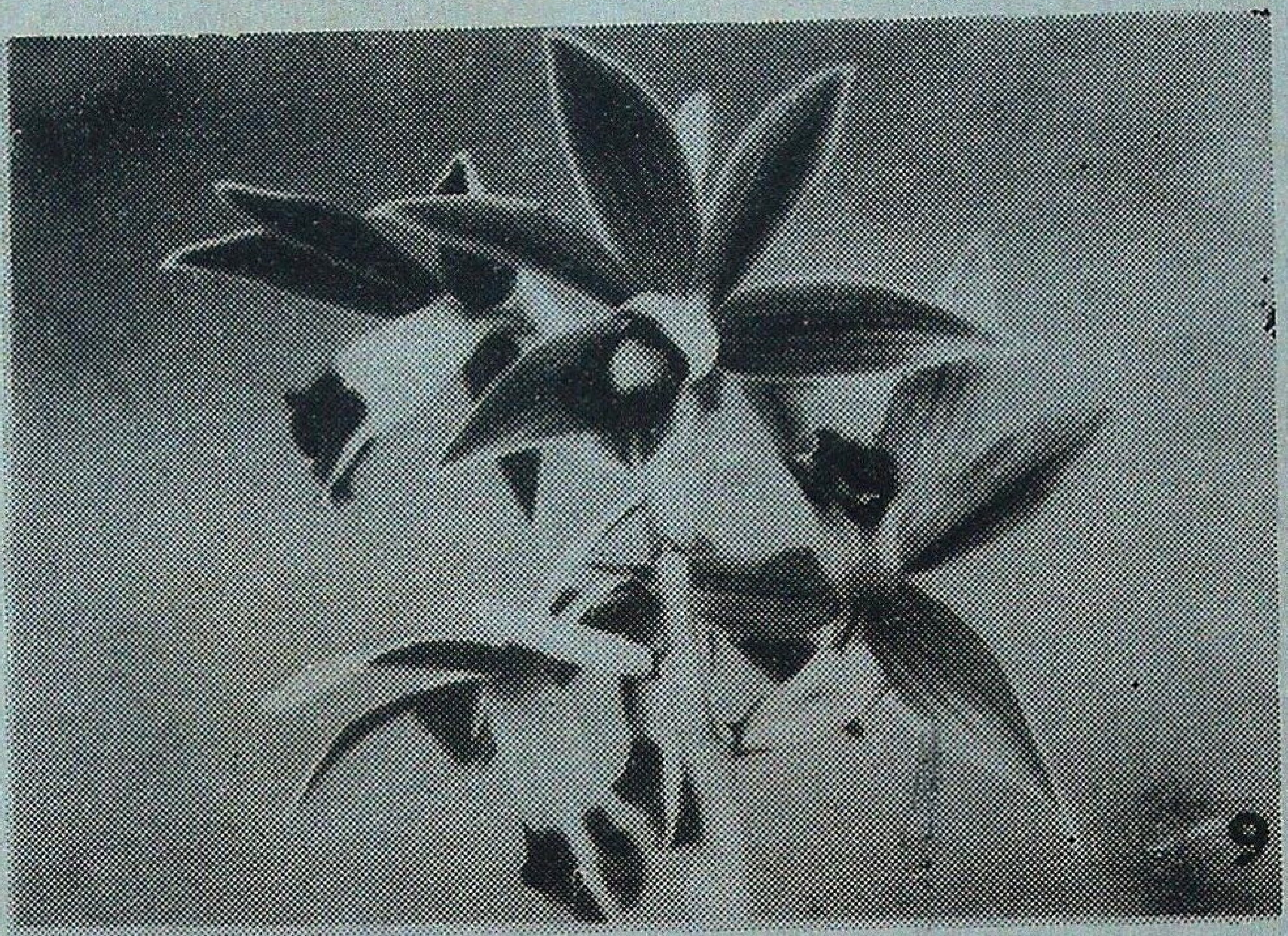

Fig. 9. Phaius wallichii

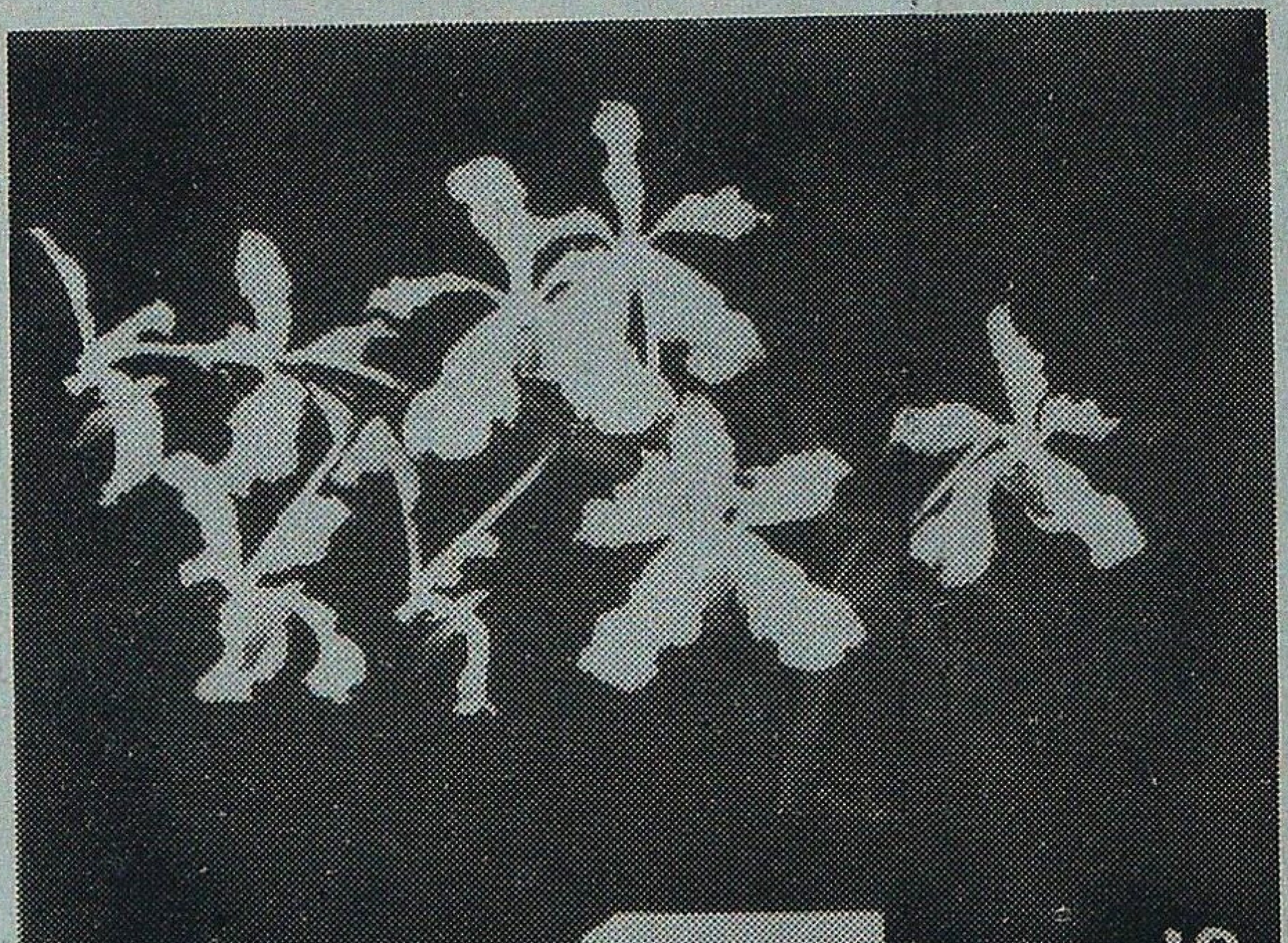

Fig. 10. Vanda Coerulea

and culture banks. This should also include the teaching of the technique of propagation of rare species. Small growers can be taught the techniques of hybridization, seed germination, meristem culture etc. so that educated-unemployed can take it as a profession on cooperative basis as is done in other developing countries and a beginning has been made at Indian Institute of Horticultural Research, Bangalore.

(g) Establishment of seed bank of native orchid species so that the different orchid growers may exchange the seed material.

(h) To create public opinion and importance of conservation especially in the areas where orchids are in abundance through the help of audiovisual aids.

(i) Establishment of an Indian orchid society so that the public in general and members in particular can exchange their views and experiences. The Society can take up the work of bringing out suitable handout and bulletin for the general public./ The same society can deliver a series of non techncal lectures at school, colleges and at adult education centres etc.

Lastly we may add in conclusion the lines written by Prof. Kamemoto in his report to Government of India "Through the cultivation or orchids, Horticulturists can serve as agents for Conservation instead of destruction".

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SUCESSIVE IMPROVEMENT IN THE WOOD HARVESTING TECHNOLOGY IN INDIA

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Introduction

Since pre-historic time forests occupy unique position in the history of civilization. Forests provide primary requirements of life such as food, shelter and protection. Besides this, this renewable natural resource provides raw material for the large number of forest based industries. The economic life of the majority of rural population is influenced by providing minor forest products. Forests are the vital component of the ecosystem and play a dominant role in the conservation of environment. The vivid and comprehensive description of Indian forests in the mythological literature of India is ample proof of the relationship between man and forests. The Indian subcontinent was thickly wooded and the diversity of the gene pool was represented by the varied climatic zones of this vast country, ranging from high rainfall areas of tropical forests to desert areas of Rajasthan, temperate to apline and high Himalayas to the coastal regions.

Early Logging

The felling and extraction of timber is an age old phenomenon and there are historical evidences, which indicate that coniferous timber was extracted from the Himalayas and brought to the plains upto 800 kilometers or more through rivers as early as 2000 B.C. Historical evidence indicates that Indian timber was exported to persian, arabic and European countries, much before the arrival of British people in the 18th century. The Indian teak was used by the Arab for the manufacture of ships and sandal wood, satinwood, ebony and blackwood used to be transported by sea and land routes to the western market. With the advent of the British, scientific management of the forests started in India, in the late nineteenth century. The main thrust of scientific forestry was on silvicultural principles and little interest was paid to the subject of logging development. The timber was extracted through the contractors, whose sole aim was to earn profit. These contractors used the most reckless methods of extraction. With little regard to the young growth the harvesting methods adopted by the contractors, damaged the forests very badly. They used primitive tools for the extraction of the timber. With such primitive logging practices about 60 to 70% of the timber was wasted. During this period, the axe was the sole implement used for timber operation, and use of saw was unknown. It was reported in 1841 that large blocks of fine teak timber 1.25 to 1.50 metres in length and 60 cm and upwards in diameter were left at the stump site.

In 1852, for the first time, attempts were made to replace the axe with the saw for felling and conversion by Lt. Michael the then superintendent of Annamalai Forests in South India. Till the end of nineteenth century the use of saw was not known to forest workers in most parts of the country. The transportation was done through bullocks. In the hills both men and animals were used for dragging. The timber were also rolled down the hill slopes to the river for further transportation to the plains by floating. All such primitive practices contributed to huge loss of precious timber. The method was best described by Mr. Ribentrop, one of the forest officers' the *timber in the Himalayas was tumbled down the hill sides anyhow, and what escaped this rough usage was thrown into the hill streams and left to find its way? Sethi in 1970 has shown the extent* of wastage by the primitive traditional methods, as below in conifer timber.

(i) Wastage on account of high stumps 4 tc 6%.

(ii) Breakage on account of cross felling of trees 2 to 3%.

(iii) Breakage of leaning tree in felling without direction control 2 to 3%.

(iv) Splitting of bottom logs of trees felled without stem tightener 1 to 2%.

(v) Wastage on account of using axe for cross cutting logs 6 to 8%.

(vi) Wastage on account of *in-situ* conversion of logs after rough squaring 27 to 35%.

(vii) Logs in transit (river floating) - 5%.

With the advent of scientific management of forests, Indian forestry made progress and qualified foresters were appointed for the protection, conservation and efficient utilization of the forests. The science of Silviculture was put to practice and trees were marked, felled and extracted on the basis of prescribed management rules. With the progress in forestry science, Forest Research Institute and Colleges was established in 1906 at Dehra Dun for carrying out research in the forestry science. At the time of establishment of Forest Research Institute & Colleges - six Branches were opened viz. (i) Silviculture, (ii) Working Plan, (iii) Forest Zoology, (iv) Forest Botany, (v) Forest Economics, (vi) Forest Chemistry. Improved logging was yet not the priority of research.

The demand of the timber increased very rapidly due to Second World War and therefore, it was essential to explore and exploit the forest resources of remote and inaccessible hilly areas for meeting this demand. The consequent decision meant huge investments and, the traditional contractors engaged in the extraction of timber were unwilling to take up the task on account of high economic cost and investment. The Forest Department took up in some areas departmental extraction of timber. Forest tramways were introduced for transportation of timber from the remote areas. Gradually industrialization caught up and a large number of wood based industries cropped up, developmental activities and population pressure required more timber and since then the demand of timber is ever increasing.

The fast development of forest roads and the availability of cheaper transport by trucks revolutionised the logging practices in the plains. The sawing *in-situ* has been practically completely stopped in the plains. The timber is transported to the nearby townships in log form for further processing in the saw mills. In the hills the main bole trunk upto 10' to 12' "Pachhan" (Squaring) is done by axes and the conversion into sleeper sizes is still continuing by manually operated frame saws and pit-saws. The sleepers in the hills therefore, were transported by Donald gravity ropeway, dry or wet slides and Kandhandhulan etc., to the head of a stream and collected in the plains.

Establishment of Logging Branch in F.R.I.

With the increasing demand of the timber and the depleting forest wealth, the country could ill afford the huge wastage of timber resources on account of following the crude and primitive logging practices. The Government of India made arrangements with the Food and Agricultural Organization and Shri A. Huber, F.A.O. Expert visited the country during 1951-53 for studying logging practices prevalent and to suggest suitable way out. On the recommendations of Mr. Huber, F.A.O. gave some Logging Equipments to F.R.I. for trials and demonstrations in the field. During 1951 the F.A.O. sent another Expert Mr.A.Koroleff who visited India and after studying, he recommended for immediate establishment of Logging Training and Research Centre. He also supplied large number of books and literature on logging to F.R.I. library. Thereafter, the *Logging Branch was established in 1957 in F.R.I. for the purpose of training* *in basic mechanization in timber harvesting, improved logging methods and carrying out research in logging.*

The early objectives of the logging branch can be summarised viz.(i) to introduce improved logging tools and equipments and to develop techniques for felling, logging, dragging, transportation and tool maintenance,(ii) to conduct demonstration in different parts of the country on the logging tools and methods, (iii) to minimise the wastage of wood and (iv) to study the tools being used by the workers, and provide them better working condition.

Early achievements

In the beginning all attempts in the Logging Branch were concentrated on introduction and popularising of improved logging tools and techniques through demonstrations and training. In 1957, F.A.O. Logging expert from Switzerland organised the training in modern logging techniques and installation, use and maintenance of basic logging and mechanised equipments. In 1958 Mr. Winkelmann and four other instructors arrived with a large consignment of improved logging tools and mechanised equipments to conduct demonstration and training.

The first course in basic and mechanised logging started at Batote in Jammu and Kashmir on 17th March 1958 for a duration of four months by the Logging Branch under the guidance of foreign expert. The aim was that these trained personnels will further impart training to staff and workers in their respective field areas.

Besides this, number of field demonstrations were conducted for the benefit of high government officials, forest officers, forest contractors and workers throughout India. Lectures and demonstration in modern logging and planning were also initiated in forest colleges, to train the State Forest Officers, Ranger trainee and lateron IFS Probationers. The number of introductory and technical papers on logging were published since the time of *Sardar Niranjan Singh*, the first officer-in-charge of Logging Branch in the forestry journals.

Time and cost studies of operations by the imported tools and equipments under Indian conditions were also initiated by this branch in 1960-61. Experiments were also conducted by this branch in 1960 to determine the comparative efficiency of imported and local cross-cut saws of Indian timber. The following results proved better efficiency of improved saws :

Species	Mean time in second per square inch by different saws		
	Raker Saw	Improved Peg-toothed Saw	Local Saw
Sal	1.586	1.621	2.224
Pine	1.283	1.286	1.799
Semul	0.434	0.357	0.453
Siris	1.503	1.473	2.278

Experiments were also conducted on degree of setting of saw teeth and compared with local rough setting. The setting. of 0.3 to 0.5 mm gives better efficiency of the saw.

species	Mean time in second per square inch with different setting						Best setting
	Local	Accurate setting in mm					
		0.2	0.3	0.4	0.5	0.6	
Sal	1.536	1.830	1.326	1.506	1.332	1.464	0.3
Pine	1.228	1.644	1.212	1.054	1.074	1.188	0.4

The designs and fabrication details of improved saw were also studied with the aim of manufacturing these indigenously. The studies were helpful in improving the work efficiency, reduction in the costs and work load stress on the workers.

The Logging Branch also collected the detailed information from all the State Forest Departments regarding prevailing logging practices, problems and tools and equipments used with a view to have a broad understanding of the Indian logging for preparing plans for future logging research and developments.

Considerable work was done and the Logging Branch successfully introduced long distance skyline cranes for off-road transportation and mechanized conversion by portable saw mills. With the development of logging, machine like FRI yarder (long distance skyline crane) for uphill and downhill transportation, various types of winches, and other improvement were made for the maintenance of the existing saws.

Separation of training

After achieving initial break-through from research for meeting the increasing requirements of training the forestry personnels and forest workers in improved logging methods a separate *Logging Training Centre Project was established with the help of Logging Branch, F.R.I. in 29th Sept. 1965 with Headquarters at Dehra Dun and four other regional centres- Kulu, Chanda, Sukna and Coimbatore.* Logging Branch initially provided space, tools, machinery and staff. The Logging Training Centre Project received the assistance from the Govt. of Sweden and Finland in the form of logging tools and equipments for training purposes. The Logging Training Centre Project has now since acquired the status of an independent Institute now known as *Logging Development Institute.*

Research areas of Logging Branch

Since the setting up of Logging Branch valuable research work has been carried out. The major areas of research in the branch are :

(i) Work and cost studies of various logging tools, equipments, and operations,

(ii) Survey of existing logging tools and methods prevalent in different parts of the country and to suggest improvements for maximum output and efficiency with minimum energy consumpton,

(iii) Design and fabrications of logging equipments,

(iv) Work Physiological studies

(v) Miscellaneous.

Major achievements

The logging research carried out can be classified into four main groups.

(i) Work and cost studies,

(ii) Survey and improvements of logging tools,

(iii) Design and fabrication of logging tools and equipments suitable to Indian conditions,

(iv) Work physiological studies.

Work and cost studies

The logging hand tools and equipments were mostly brought from abroad. The first task of the logging branch was to conduct the time and cost studies on these tools so that their efficiencies could be tested for introducing the same in the field under Indian conditions. These studies were carried out and research findings were published. One of the experiments carried out on the mechanized logging equipments reveals that the running cost of Power Chain Saws per unit time is more as compared to the manual tools under Indian conditions. This is because of, weight of the saw, low labour costing in India and high price of petrol etc. Studies conducted on log transport by skyline crane in the hills reveal that the time per round trip of logs was independent of the load and higher load improves the efficiency of the machine. The studies carried out on the various modes of transportation reveal that the bullock can be used economically only upto 4.25 km and beyond this the truck transport is cheaper. So far 42 technical papers have been published on this subject.

Survey and improvement of logging tools

At present, inferior quality and old outdated tools are being used, which are highly unproductive energy consuming and risky. There is scope to make improvements in all these tools and equipments. Crude hand tools are still prevalent; this results in wastage of timber, loss of time, excess energy expenditure, less out turn and high chances of accidents.

Work on this aspect has been taken up by the branch. Field studies are undergoing in the States of Karnataka, Kerala, Andhra Pradesh and Tamil Nadu. The information already collected is under analysis. Further studies are to be carried out in the field all over India so that suitable modifications are suggested in the basic logging tools, for different parts of the country.

Design and fabrication of logging tools and equipments

The improved mechanized logging equipments were brought from abroad which were suiting to Indian conditions with necessary modifications. Thus the branch popularised these machines with modification and encouraged the manufacturing in India. Some important equipments were also designed and fabricated in this Branch. The F.R.I. yarder for long distances Skyline Crane was fabricated in this branch using all indigenous components.

The other important machines fabricated in the branch were

(i) Series of Mini Winches for extraction of fuelwood, softwood and Bamboo using 1.5 H.P. Engine.

(ii) Series of Winches for uphill haulage of pulpwood using 5 to 10 B.H.P. Engine.

(iii) Bamboo cutting machine,

(iv) Tractor Winches for log skidding etc.,

(v) Intermediate support for Wire skidding equipment,

(vi) Simple carriage for uphill transportation of small timber.

11Eleven papers were published on the subject.

Work physiological studies

Logging is a hard and strenous

work. The operation consumes much energy as well as time. It was felt necessary to assess the general health and socio-economic condition of forest workers. The research projects were started in the Fifth Five Year Plan to find out the general health, nutritional status, socio-economic conditions and maximal/sub-maximal aerobic capacity, energy expenditure in K. cal/Min. in various logging operations. The physical fitness and work capacity of forest workers in high hill forests was found better than those in the plains. Felling and cross-cutting operations by manual saws were found to put very high load on the body upto 62% of the maximal aerobic capacity as against allowable work load of 30 to 40%. Energy expenditure in imporved raker saw was found less to gether with higher efficiency as compared to pegtoothed saws. The Power Chain Saw involves only 24% of the maximal power of the worker. So far 8 papers have been published on the subject.

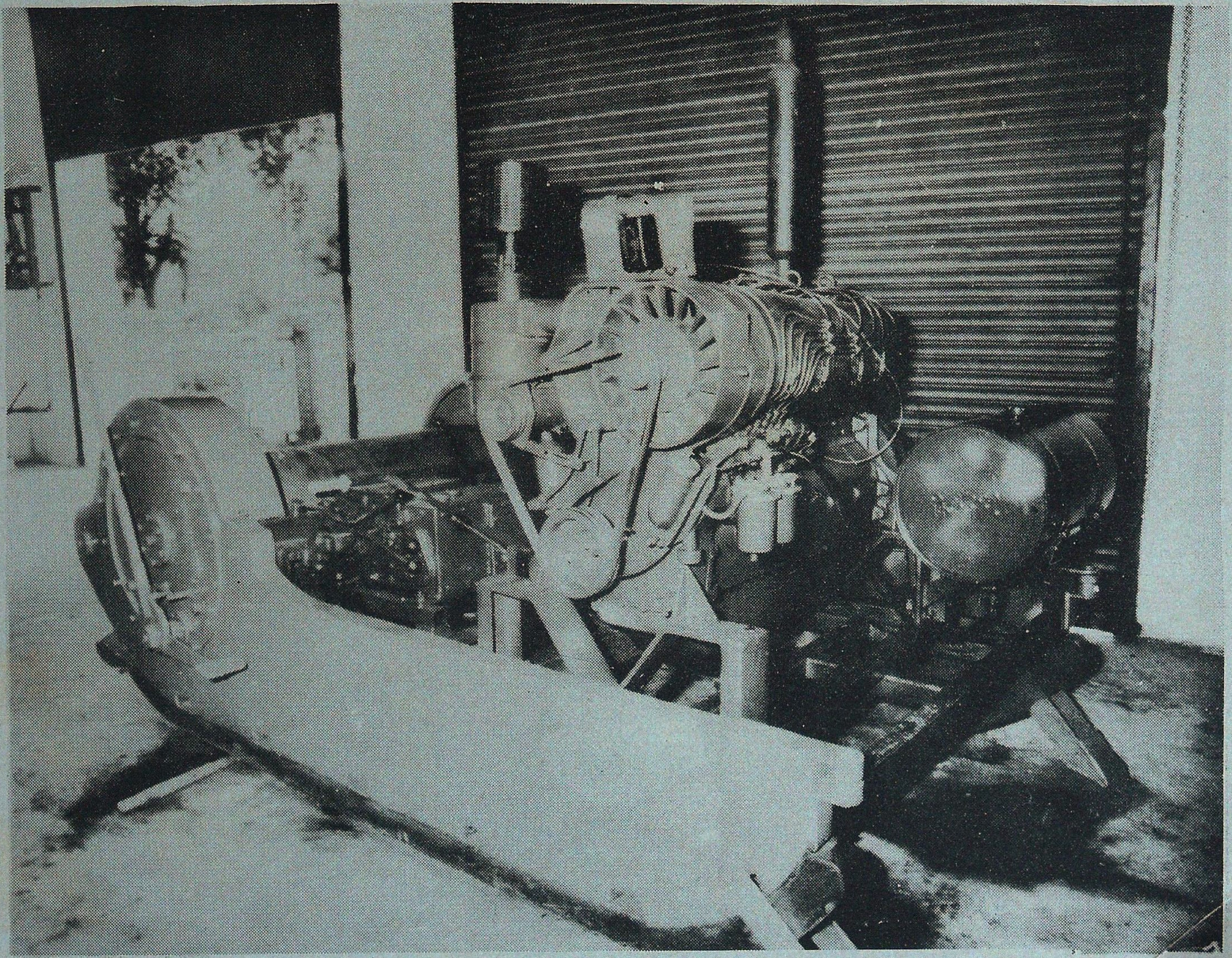
In addition to above, several miscellaneous papers were published on logging problems by the logging branch. The number of such paper is 18 and all these papers proved very helpful in the identification of logging problems in the country.

Scope of future logging research

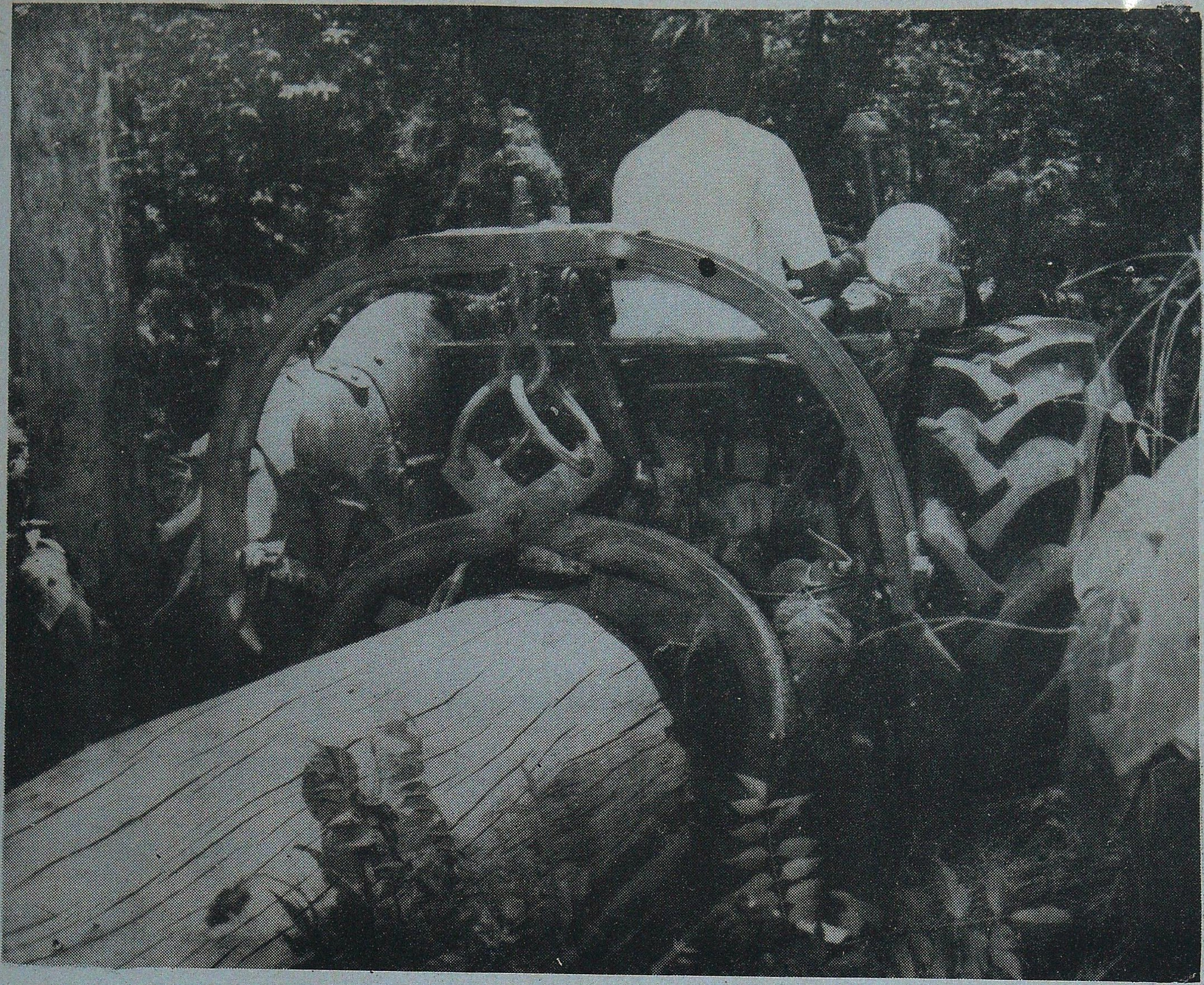
As will be clear from the above account the science of logging has carved out definite position for itself in the forestry science of the country. The future research and development programme in logging should concentrate on.

(i) Physiological and Ergonomical Research : With the empasis on improving the living conditions of the people, we will have to concentrate our research work on the Physiological studies of forest workers. Logging operations are very tough and demand maximum energy output from the workers in difficult terrain. The workers are exposed to accidental risks and injuries which are sometimes fatal. It is, therefore, essential to develop machine and logging tools which suit the physiological status of the forest workers so that they are able to do the work according to their energy capacity. This will avoid undue strains on the workers and will consequently lead to more economic logging operation. This will attract the worker to logging operation as at present the workers are reluctant to work in the logging and prefer other less strenous works in agriculture and other forestry activities.

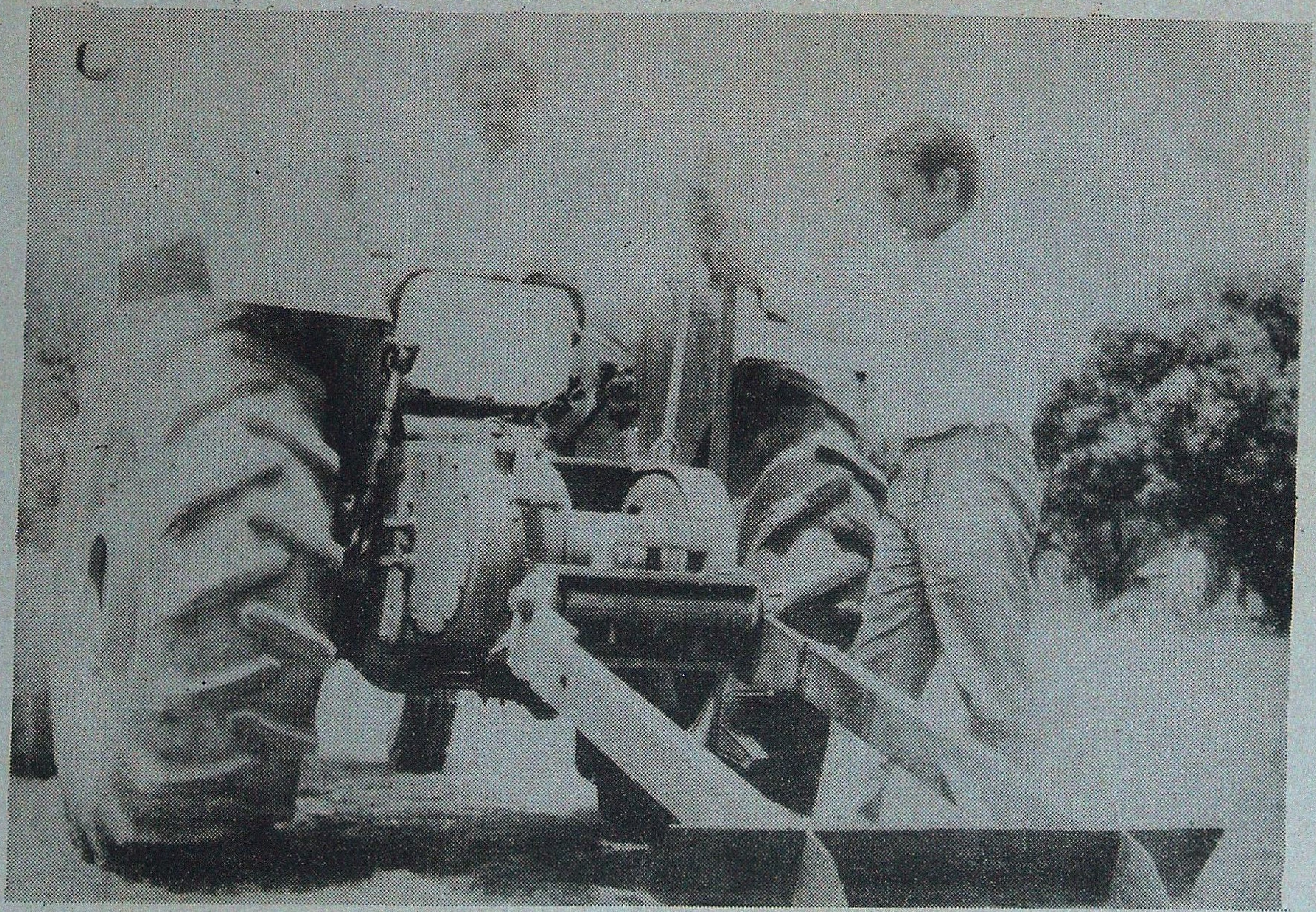
(ii) The socio-economic millieu of our country is different from advanced coutries and, therefore, we shculd not go blindly for the foreign highly mechanized logging equipments. However, mechanization can be thought of in some selective areas. Our basic resources, needs and conditions are different and thus we



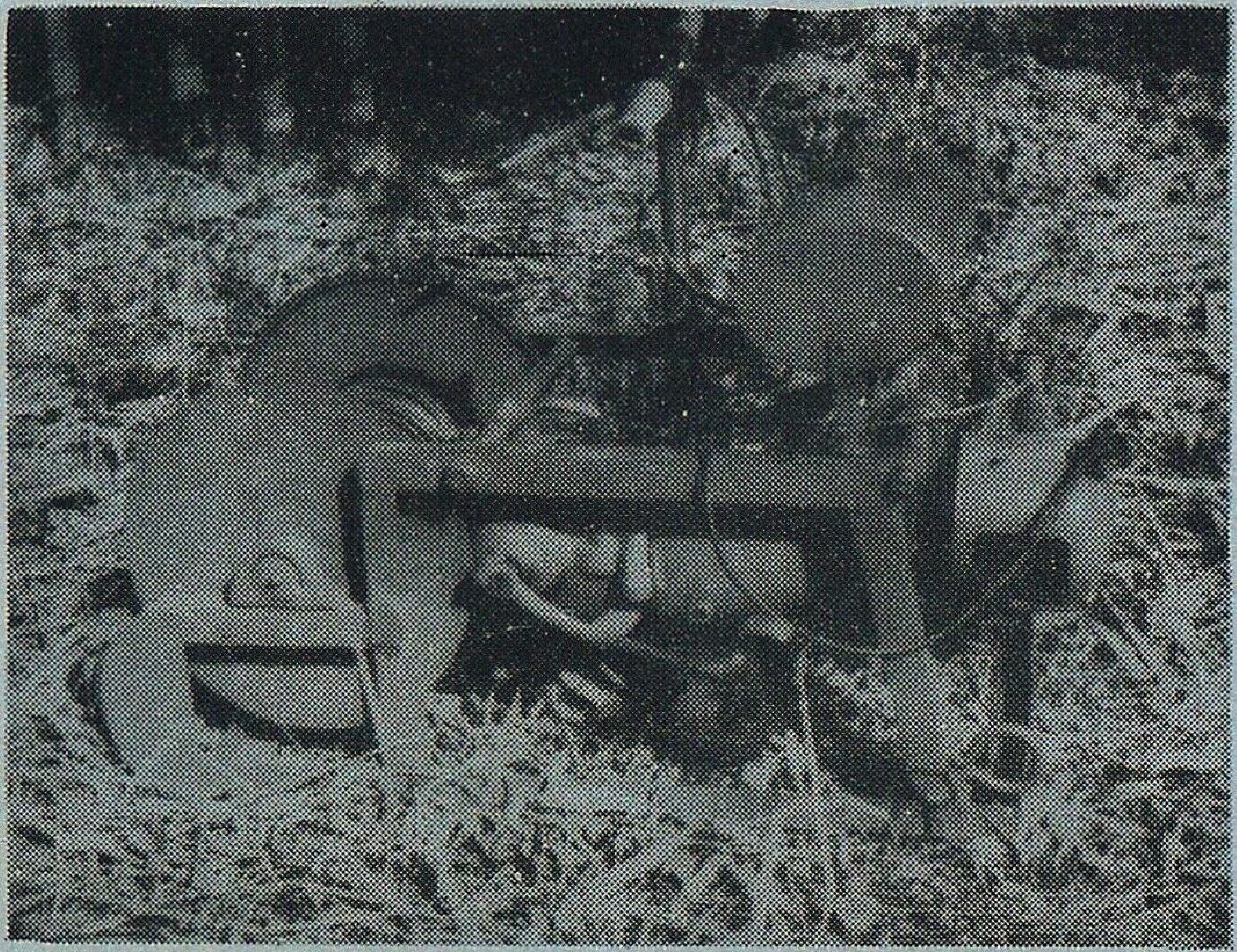
No. 1. F.R.I. YARDER (LONG DISTANCE SKYLINE CRANE).



No.2 CALLIPER GRAB ATTACHED WITH TRACTORFOR DRAGGING OF LOGS.



NO. 3. TRACTOR WINCH FOR SKIDDING ETC.



No. 4. MINI WINCH FOR EXTRACTION OF BAMBOO USING 1.5 H.P. ENGINE.

No. 5. BAMBOO CUTTING MACHINE.

have to modify the methods according to our needs. Our logging tools and methods should be economically viable, can work in all our conditions and are suitable to us operationally, as well as,acceptable to the workers.

(iii) *Transportation* : Studies should be carried out on the economics of existing transportation methods loading and unloading and improvements to be suggested.

The future logging research should be conducted by identification of problems, through proper planning with respect to the areas of the operation, harvesting stock, nature of terrain, availability of transportation and knowledge of timber marketing which include market intelligence. There should be close relationship between the silvicultural prescriptions and logging operations for successful logging operation in particular, and forest management in general.

The success of logging development can be best described in the words of Mr. S. Shayam Sunder, CCF, Karnataka "Through better logging technique and tools Karnataka could increase its forest revenue by almost 7 crore of rupees" (quoted from the leaflet published by logging Development Institute).

SUMMARY

Forests are the most important natural resources available at the disposal of Man. The harvesting of the Forest products is an age old phenomenon and as back as 2000 B.C., The Indian timber was exported to the western and arabic countries. The logging tools prevalent in India were primitive and less productive, resulting in colossal loss of most valuable timber. In India, even after introdction of scientific management of Forests, principles of Silvicultural science took precedence over all other forestry activities and improved logging was not yet on the priority. In 1852, for the first time, attempts were made to replace the axe with the saw for felling and conversion. The demand of timber increased steeply after the second World War and need was felt to extract the timber from the inaccessible hilly areas. With the introduction of Truck transportation and roads and Bridge construction the timber harvesting operation, were revolutionized in the plains. After Independence, the demand further increased on account of population pressure and development and since then the demand of timber is always increasing. With this demand, need was felt to improve the logging practices and F.A.O. Expert Mr. A. Huber visited India during 1951-53. Another F.A.O. Expert Mr. A. Koroleff also visited India in 1951, on the recommendations of these experts, *Logging Branch was established in 1957 in FRI* for conducting research and imparting training in basic logging to the Foresters and forestry workers. After

achieving initial Breakthrough, the need was felt to separate training from the research, which led to the establishment of *Logging Training centre Project in 1965*, with H.Q. at Dehra Dun and Four Regional Centre. The centre has since acquired the states of *Logging Development Institute.*

The major achievements of the research carried out by the Logging Branch are in the field of *work and cost studies, Survey and improvements of logging tools, Design and fabrication* of logging tools suitable to Indian condition such as FRI yarder (long distance skyline crane), *various types of winches and improvements in the saws and work physiological studies.* In future emphasis should be laid on research on the Ergonomic aspects, to devise suitable tools and equipments for logging operations which are economically viable, can work in our conditons and which are acceptable to the workers. Transportation studies should also be carried out. There should be close link between the Silvicultural prescriptions and Logging operation.

भारत में काष्ठ की सस्य कटाई—प्रौद्योगिकी में हुए क्रमिक परिष्कार

वी० के० बहुगुणा

सारांश

मानव उपयोग के लिए उपलब्ध सबसे अधिक महत्वपूर्ण प्राकृतिक संसाधनों में बन आते हैं। वनोत्पादों की सस्य कटाई प्राचीन काल से चली आ रही है। २००० ईसा पूर्व में भी भारतीय प्रकाष्ठ पश्चिम के और अरब के देशों में निर्यात किया जाता था। प्रकाष्ठ–निष्कासन में उपयोग किए जाने वाले भारत में प्रचलित औजार आदिम किस्म के और कम उत्पादक थे जिसके कारण बहुत मूल्यवान प्रकाष्ठ की भारी बरबादी होती थी। भारत में वनों का वैज्ञानिक प्रबन्ध आरम्भ कर दिया जाने के बाद भी, वनसंर्धन विज्ञान के सिद्धान्त वानिकी के अन्य कार्य-कलापों पर अधिमान्य बने रहे और परिष्कृत प्रकाष्ठ-निष्कासन को तब भी कोई पूर्वता नहीं मिल सकी। सर्व प्रथम 1852 में पेड़ गिराने और चिरान करने के लिए कुल्हाड़ी की जगह आरा उपयोग में लाने की कोशिश की गई। दूसरे विश्व महायुद्ध के बाद लकड़ी की मांग बहुत तेजी से बढ़ती चली गई और दुर्गम पहाड़ी क्षेत्रों से भी प्रकाष्ठ निष्कासित करने की आवश्यकता अनुभव की गई। मोटर ठेलों द्वारा परिवहन आरंभ हो जाने और सड़कें और पुल वन जाने से मैदानों में प्रकाष्ठ की सस्य कटाई में मानो एक क्रान्ति ही हो गई। स्वतन्त्रता मिल जाने के बाद आबादी का दबाव बढ़ने और विकास के परिणाम स्वरूप लकड़ी मांग में और वृद्धि हुई और तब से लकड़ी की मांग निरन्तर बढ़ती ही जा रही है। मांग. बढ़ती रहने से प्रकाष्ठ-निष्कासन रीतियों में सुधार लाने की आवश्यकता अनुभव की गई और खाद्य एवं कृषि संगठन के विशेषज्ञ श्री ए० ह्यूबर 1951-53 के दौरान भारत में आए। एक दूसरे खाद्य एवं कृषि संगठन विशेषज्ञ श्री ए० कोरोलफ भी 1951 में भारत आए। इन विशेषज्ञों की सिफारिशों पर वानिकों और वानिकी कार्यकर्त्ताओं को आधारभूत प्रकाष्ठ निष्कासन का प्रशिक्षण देने और उसमें अनुसंधान करने के लिए वन अनुसंधान संथान में 1957 में प्रकाष्ठ निष्कासन शाखा स्थापित की गई। प्रारम्भिक कार्य पूरा कर चुकने के पश्चात प्रशिक्षण को अनुसंधान से पृथक करने की आवश्यकता अनुभव हुई जिसके परिणाम स्वरूप 1965 में प्रकाष्ठ निष्कासन प्रशिक्षण केन्द्र परियोजना बनाई गई जिसका मुख्यालय देहरादून में रखा गया और चार क्षेत्रीय केन्द्र बनाए गए। यह केन्द्र अब उन्नति करके प्रकाष्ठ निष्कासन विकास संस्थान बन चुका है।

प्रकाष्ठ निष्कासन शाखा में किए गए अनुसंधान की मुख्य सफलताओं का संबन्ध कार्य और लागत का अध्ययन, प्रकाष्ठ निष्कासन उपकरणों का सर्वेक्षण और परिष्कार; भारतीय दशाओं के लिए उपयुक्त प्रकाष्ठ निष्कासन के उपयुक्त उपकरणों का आकल्पन और निर्माण जैसे एफ आर आई यार्डर [लंबी दूरी की हवाई क्रेन], विभिन्न प्रकार की आमणियों तथा आरों में परिष्कार और कार्य के देहव्यापारिकीय अध्ययनों से है। भविष्य में किए जाने वाले अनुसंधान का जोर श्रमआर्थिकी [एर्गोनोमिक्स] पक्षों पर रहेगा ताकि प्रकाष्ठ-निष्कासन कार्यों के लिए ऐसे उपयुक्त औज़ार और उप साधन बनाए जा सकें जो आर्थिक दृष्टि से भी ठीक हों, हमारी दशाओं में काम आ सकते हों तथा जो काम करने वालों को भी स्वीकार हों। ढुलान अध्ययन भी किए जाने चाहिए। वनसंवर्धन के आदेशों और प्रकाष्ठ निष्कासन कार्यों में पूरा-पूरा सम्पर्क बना कर रखा जाना चाहिए।

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FOREST PATHOLOGY IN INDIA: PROBLEMS AND CONTROL STRATEGIES

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Forest Pathology originated as a science in 1870 when Robert Hartig, a German forester, became the first investigator to diagnose properly the relation of fungous hyphae in decayed wood to the fructifications on the tree. The discipline has its origin in North America about 1900; in Japan, Australia and New Zealand in 1930's and in parts of Africa and in parts of Africa and South America in 1950's (Hepting 1977). In India, though forest fungi have been collected, identified and South America in 1950's (Hepting 1977). In India, though forest fungi have been collected, identified and published by various scientists since 1860's, the real work of *Casuarina equisetifolia*. Since then, many disease problems occurring in Indian forests have been identified, studied and account published. The present paper aims at highlighting disease problems of Indian forests and control strategies which have generally been adopted in our country.

Disease problems

Disease problems investigated in the country may be divided into four parts i.e. nursery diseases, diseases in natural forests, diseases in plantations raised in forest areas and diseases in social forestry plantations.

Nursery diseases : In nurseries, the plants are concentrated in a limited space; these are watered regularly and nursery soil is usually heavily manured. All these factors together contribute towards development of disease epidemics in nursery seedlings resulting sometimes in nearly total destruction of nursery stock. For reforestation of forest sites, nurseries are raised within forest areas. Most of the diseases occurring in nearby natural forests/plantations usually establish in such nurseries. Important such disease pathogens recorded in forest nurseries include foliage rust (*Olivea tectonae*) and mildew (*Uncinula tectonae*) on teak *Melampsora ciliata* (foliage rust) and *Cladosporium humile* (leaf spot) on poplars, Cylindrocladium leaf spot and twig cankers on eucalypts, poplars and other species, *Revenelia* spp. attacking *Albizia* spp. and *Acacia* spp. and a large number of leaf spot pathogens attacking seedlings in nurseries. Residual roots and stumps of old forest trees left in the nursery site are invariably infected by root-rot pathogens which subsequently transfer to nursery plants and cause heavy mortality. Rosellinia root-rot in poplars has been recorded in nurseries causing large scale mortality in cuttings.

Disease pathogens in forest nurseries may also be introduced along with seeds, or other planting stock imported from foreign countries or when the planting material is taken from one nursery to another or from plantations/natural forests to nurseries. *Botryodiplodia palmarum* is introduced nurseries on poplar cuttings collected from natural forests/plantations/ other nurseries. *Fusarium semitectum* causing seedling mortality, gummosis & stem canker on su-babul is seed borne & is thus carried on seeds from one region to another (Sujan Singh *et al* 1983a, 1983b & 1983d). *Cercoseptoria pinidensiflorae*, an exotic pathogen attacking hard pines and inadvertently introduced in the country, is believed to have got into the nurseries on infected needle bits which are usually found mixed with seeds (Sujan Singh 1982). This pathogen has now established almost all the exotic pine nurseries in Orissa, Andhra Pradesh, Madhya Pradesh, Himachal Pradesh and Uttar Pradesh. *Dothistroma pini*, a serious leaf blight pathogen attacking *Pinus radiata* Bakshi and Sujan Singh 1968) is also believed to have been introduced in the pine nurseries through seeds, probably on infected needle bits.

In addition to the above pathogens, by far the greatest amount of damage to nursery stock is done by soil-borne pathogens causing damping off diseases. Species of *Fusarium*, *Ryhium* and *Rhizoctonia solani* have been found to cause damping off in conifer nurseries (Reddy 1969). *Fusarium avenaceum* has been found common and most damping in spruce and fir nurseries in Hamachal Pradesh. *Rhizoctonia solani* has been found to cause damping off in seedlings of *Populus ciliata*, many species of *Acacia* and many other hardwood species. Species of *Cylindrocladium*, *Pythium*, *Rhizoctonia solani* and *Sclerotium rolfsii* have been found to cause heavy damage in *Eucalypus* nurseries in Kerala State (Sharma *et al.*, 1984).

Nurseries for social forestry plantations are usually raised on agricultural land, or on strips of land along roads/railway tracks/ canals/rivers. Such soils are usually unsuitable for raising tree seedlings due to their neutral or alkaline pH and high concentration of salts at some places. Damping off fungi like species of *Pythium* and *Phytophthora* which are common in agriculture crops usually establish in these nurseries. A heavy mortality involving death of over 50,000 seedlings of *Eucalyptus* hybrid was recorded in Aligarh district of Uttar Pradesh due to collar rot caused by one of the above two species.

In additon to the damping off diseases, social forestry nurseries also suffer from all types of diseases which occur in forest nurseries as these diseases may be introduced in these nurseries through infected seeds/seed debris/leaves/leaf mulch/cuttings/live seedlings from diseased areas.

Social forestry nurseries are usually exposed to hot winds and high temperatures as these are generally not surrounded by forest crops. Hot winds dry the soil in polypots and this results in accumulation of salts on soil surface. Collar rot in *Eucalyptus* seedlings in social forestry nurseries in Uttar Pradesh was found both due to high temerature at soil level and accumulation of salts at the surface of polypot soil.

Disease problems in natural forests: Diseases in natural forests usually remain under control due to genetic diversity and mixed nature of these forests and also due to long association of tree species with local pathogens. In cases where the natural forests are subjected to over-exploitation, extensive grazing, repeated fires and other malpractices or are affected by adverse environmental factors, disease epidemics may occure. Large scale dying of sal in Bihar during 1950's was due to site deterioration, most important single factor being leassened amount of soil moisture resulting from repeated fires, over-grazing etc. The sal trees thus weakened were attacked by a weak pathogen, Hypoxylon *maditerraneum* variety *microspora* which hastened the death of affected trees (Boyce and Bakshi, 1959; Bakshi, 1963). Large scale dying of teak in Maharashtra and Madhya Pradesh during 1960's was due to successive droughts for many years (Bakshi *et al.* 1972)

Root-rots in natural forests generally remain in endemic form and cause killing of scattered trees. *Heterobasidion annosum* and *Armillariella mellea* causing root-rot of deodar, fir and spruce, *Ganoderma lucidum* causing root-rot of khair, sissoo and various other species specially those belonging to family Leguminosae and *Polyporus shoreae* causing root-rot in sal are most important root-rot pathogens occurring in Indian Forests in endemic state causing sporadic death of susceptible tree species from time to time. Any deviation in management practices which may be deleterious to tree species and favourable to root pathogens sometimes results in epidemic spread of root-rots caused by these pathogens. Root-rot of sal due to *Polyporus shoreae* in high rainfall areas of

North Bengal and Assam spread in epidemic form during 1950's due to fire protection measures adopted in early age of the crop, as such measures resulted in building up of high soil moisture favouring developmentdd of *Polyporus shoreae* in epidemic form. High soil moisture also lead to progression to mixed evergreen forest which factor affected growth of sal trees (Bakshi 1976).

Heart-rot is the commonest disease in natural forests and this disease results in great loss of merchantable timber. During a study on heart-rot in sal, 73 per cent trees were found affected by heart-rot entailing a loss of 9.73 per cent of timber volume (Bakshi *et al.*, 1963). Common heart-rot fungi occurring in Indian forest are *Fomes caryophylli*, *Hymenochaete rubiginosa* and *Fomes fastuosus* on sal, *Fomes badius* on Khair, *Fomes pini* on blue pine, *Peniophora luna* on deodar, *Fomes pachyphloeous* on poplars among many others.

Disease problems in plantations raised in forest areas : Mortality due to root-rot is the most serious problem in tree plantations raised after clearfelling natural forests. Root-rot pathogens existing in endemic form in natural forests often develop into epidemic proportions on residual stumps and roots left in the site after clearfelling the area. Such pathogens cause heavy losses in susceptible crops raised subsequently on the site. *Ganoderma lucidum* was found to cause 55 per cent mortalit in khair plantations in Siwalik forest division (U.P.) during first nine years of plantation age (Bakshi *et al.* 1976) and 41.7 per cent mortality in a seven year old poplar plantation in Dehra Dun East forest division (U.P.) (Sujan Singh and Khan 1979b). Mortality due to *Heterobasidion annosum* and *Armillariella mellea* was assessed in 1978 as 21 per cent and 1.8 per cent respectively in 12 year old plantation of deodar and due to *A. mellea* as 2.3 per cent in 12 year old fir plantation in Chhachpur (Himachal Pradesh) (Sujan Singh and Khan 1979a).

Site is an important factor for raising healthy tree plantations. Unsuitable sites predispose trees to attack by pathogenic fungi. Sissoo (*Dalbergia sissoo*) suffers from high mortality due to wilt disease caused by soil-borne pathogen, *Fusarium solani* when the species is raised on sites with stiff and clayey soils with poor drainage and on water-logged soils where repeated inundation of roots in sub-soil water results in killing of finer roots which are subsequently colonized by the wilt pathogen (Sujan Singh 1980). *Eucalyptus citriodora* is native to a climate where it cannot stand even light frost. The species suffered heavy mortality in Bijnor (Uttar Pradesh) due to stem cankers caused by frost (Bakshi and Sujan Singh 1964). Black wattles in their indigenous home in Australia and Tasmania occur in cool and moist locations where winter temperature does not go below 4.4° C. Wattle plants suffered seriously from frost damage in Kodaikanal (Tamil Nadu) (Bakshi *et al.* 1972).

Trees in plantations are well managed and thus generally remain free from heart-rot and other stem diseases. If however, the plantation trees are subjected to injuries on the stem, diseases including heart-rot may cause serious damage to standing trees. *Casuarina equisetifolia* suffers from heavy mortality due to stem wilt caused by *Trichosporium vesiculosum*. The pathogen enters the trees through injuries caused by illicit lopping or injudicious pruning of branches on the trees (Bakshi 1951). Poplars in agroforestry plantations are subjected to basal injuries by tractor blades during ploughing operations for cultivation of land within poplar lines. These injuries are subsequently colonized by heart-rot pathogen, *Fomes pachyphloeous* which causes extensive heart-rot in these poplar plantations.

Exotic tree species suffer seriously in plantations when these are attacked by indigenous pathogens against which these pathogens did not have any change to develop resistance. *Corticium salmonicolor*, the pink disease pathogen, caused 50-100 per cent mortality in *Eucalyptus grandis*, *E. tereticornis* and *E. citriodora* in high rainfall areas of Kerala, Karnataka and Goa States during 1980's (Seth *et al.* 1978). *C. salmonicoloris* a native pathogen and ecalyptus being exotics did not have any chance to develop resistance against this pathogen and thus suffered heavily. Similarly exotic poplars are found to be heavily damaged by this pathogen under high humid environments (Sujan Singh and Khan 1979b). *Pinus canariensis*, an exotic pine, was wiped out in Ranikhet (Uttar Pradesh) due to attack of *Cronartium himalayense*, the stem blister rust attacking indigenous pine, *Pinus roxburghii, in these areas* (*Bakshi and* Sujan Singh 1972). Exctic *Cupressus* spp. were heavily damaged by *Monochaetia unicornis* which caused stem and branch cankers in New Forest, Dehra Dun (Uttar Pradesh) (Bakshi *et al.* 1972).

Exotic pathogens if inadvertently introduced into a country may cause heavy damage to their exotic hosts as well as some indigenous tree species which may show susceptibility tosuch pathogens. *Pinus radiata* planted in Palni Hills of Tamil Nadu State was almost wiped out by needle blight pathogens, *Dothistroma pini* (Bakshi and Sujan Singh 1968) introduced probably along with the seeds of *Pinus radiata*. Another needle blight caused by *Cercoseptoria pini-densiflorae*, an exotic pathogen inadvertently introduced in the country, not only attacks exotic pines in plantations but has been found to attack indigenous pine, *Pinus roxburghii* also. Most of the exotic pines are found to develop resistance against this pathogen but *Pinus roxburghii* continues to be attacked and suffer seriously by this pathogen in plantations (Sujan Singh *et al.* 1982).

Foliage pathogens in hardwood tree species rarely become serious in plantations as infected foliage is shed along with healthy leaves during normal leaf fall. Under high humidity and in high density plantations, foliage pathogens also sometimes cause serious losses in plantation crops. Important foliage pathogens which can become serious under such conditions are foliage rusts (*Marayalia achroa* on sissoo,*Olivea tectonae* on teak, *Melampsora spp.* on populars), mildews (*Uncinula tectonae* on teak, *Phyllactinia dalbergiae* on sissoo, *Uncinula salicis* on populars and willows) and leaf spots caused by large number of fungal pathogens attacking various hardwood tree species.

Some rust pathogens become serious on plantation trees when their alternate host is present within these plantations. A serious epidemic of *Chrysomyxa himalensis* was recorded in Ranikhet (Uttar Pradesh) n a small spruce (*Picea smithiana*) plantation during 1980-1982. The rust patogen has its alternate stages on *Rhododendron arboreum* which occurred as scattered trees within or around spruce plantation. *Cronartium himalayense*, the stem rust of chir pine (*Pinus roxburghii*) caused heavy losses during 1920's and again 1960's in hill areas of Uttar Pradesh as the alternate host, *Suertia* spp. was heavily infected by this rust. The disease epidemic was automatically controlled when the alternate hosts,*Suertia* spp. were wiped out by the rust or through collection by local people for medicinal purposes.

Disease problems in social forestry plantations: Social forestry plantations are raised outside forest areas on farm land,along roads, railway tracks,rivers, canals and on *Panchayat* lands.Such varied types of situations expose these plantations to varied types of diseases. Diseases normally present in forest areas establish in these plantations also. Such disease pathogens are mostly introduced in these plantations through seeds/seed chaff/leaves/needles used as packing material/live nursery seedlings. Ganoderma root-rot common in forestry plantations causes extensive damage in social forestry plantations also. During recent field surveys, a heavy mortality of *Acacia nilotica* and *A. tortilis.* was recorded due to Ganoderma root-rot in Ferozepore (Punjab), Jodhpur (Rajasthan) and Mohindergarh (Haryana). Stem and twig cankers caused by *Corticium salmonicolor* and leaf and twig blight caused by *Cylindrocladium quinqueseptatum*, the two common diseases in forest areas,also occur commonly on eucalypts in social forestry plantations.

Trees in social forestry plantations also suffer from diseases commonly found on agriculture crops. *Fusarium semitectum* has been found to cause seedling mortality, gummosis and stem cankers in *Leucaena leucocephala* in social forestry plantations. The pathogen has been found to attack many agriculture crops/weeds growing in agriculture fields (Sujan Singh *et al.* 1983a,1983d).

Control strategies

Forest trees occupy the site for prolonged periods ranging from 10 years to over 100 years. Intensive disease control measures by use of chemicals as practised in agriculture crops are,therefore, not always possible in tree crops. An approach towards integrated control measures based on principles of exclusion (avoiding to take pathogens to pathogen free areas), avoidance (Avoiding to take tree species to diseased areas), eradication (of infected host/tree pathogens) and protection of trees from attack of disease pathogens is, best suited for control of forest diseases. These principles vis-a-vis diseases recorded in Indian forests are briefly described below.

Exclusion of pathogen: Exclusion of exotic pathogens from the country can best be achieved by strictly following quarantine practices. After the planting material is released by the quarantine authorities, this should be again checked by the concerned importers to detect the presence of any fungal pathogen. All seed debris found mixed with seeds should be removed before sowing seeds in the nurseries. Within a country, spread of diseases can be checked if only healthy seedling stock is moved from one region to another. For raising social forestry plantations, seedlings raised in forest nurseries should not be used.

Most of species and clones of exotic poplars have been found highly susceptible to *Melampsora ciliata* which usually occurs on *Populus ciliata* in hill areas of Uttar Pradesh and Himachal Pradesh (Sujan Singh *et al.* 1983d). Cuttings from exotic poplars raised in hill areas and from *Populus ciliata* should not be planted in nurseries in plain areas unless it is ensured that the cuttings have been obtained from areas where Melampsora rust is absent.

To check further spread of Cercoseptoria needle blight in chir pine, the planting of exotic pines in natural zones of chir pine should be avoided. No pine seedlings from Cercoseptoria infected nurseries should be planted in the field unless these seedlings are sprayed with 0.6 per cent suspension of dithane M-45 or Cuman-L fungicides (Sujan Singh 1982).

In dry areas, soil in polypot seedlings is covered by leaf mulch to avoid drying of top soil. Such leaf/needle mulch in case of pines should not be collected from areas where needle diseases of pines had been recorded. In case of hardwood seedlings also, care should be taken that leaves used as mulch are not attacked by leaf disease pathogens.

Mycorrhizal soil usually gets mixed up with pine needles infected by foliage pathogens. It is, therefore, very necessary that mycrrhizal soil is collected from healthy plantations.

Avoidance : It is most prudent in any forestry operation that raising of susceptible tree species is avoided on sites where there is a potential risk of any disease development in epidemic form. Ganoderma root-rot develops in epidemic form on residual roots and stumps of previous crop after clearfelling a natural, mixed forests and causes heavy mortality if susceptible tree species is raised on such sites. Raising of species susceptible to Ganoderma root-rot such as khair, sissoo, eucalypts and poplars should, therefore, be avoided in first rotation on such sites.Instead, resistant species like *Ailanthus*,semal and teak should be raised on such sites in the first rotation. By the time, these resistant species complete their rotation, infected root mass of previous crop gets disintegrated and lost in the soil.

Pink disease in eucalypts develops in epidemic form in high rainfall areas where rainfall is more than 250cm per annum and high humidity prevails for prolonged periods (Seth *et al.* 1978; Sujan Singh *et al.* 1979). Species of eucalyptus susceptible to pink disease should not be raised on such sites.

Sissoo suffers from wilt disease when the species is raised on stiff and clayey soils with poor drainage and on sites with high water table. For raising sissoo, soil should, therefore, be of sandy or sandy loam texture. In high water table areas, it is always better to raise sissoo plantations from root-shoot cuttings to encourage the plants to develop shallow root system so that killing of finer roots by repeated inundation in sub-soil water can be avoided (Sujan Singh 1980).

Tree species attacked by heteroecous,macrocyclic rust pathogens should not be raised in areas where alternate hosts of such rust pathogen is present and infected by the rust.

Eradication : Disease control by eradication of infected hosts and/or disease pathogen is most commonly practised in Indian forests. Improvement felling by removal of diseased and dead trees is normal silvicultural practice in most forest tree species. In sal forests, trees infected by heart-rot pathogens, can be easily identified by presence of sporophores (*H.rubiginosa*), punk knots (*Fomes caryophylli*), swollen boles, swollen knots, hollows, and open wounds (Bakshi *et al.* 1963). In selection fellings, such trees should be marked and removed first as heart-rot being progressive decay will continue to decay the heart wood in affected trees if left in the forests. Control of heteroecious, macrocyclic rusts on pines is best achieved by eradication of alternate, unecnomic host from affected areas.

Sanitation is an important eradication measure. Under this, diseased trees/parts of trees/diseased seedlings in nurseries are collected and either burnt or buried in soil.

Eradication of fungal pathogen also contributes to a great extent in checking further spread of diseases. Knocking off *Fomes badius* fruit bodies from khair trees suffering from heart-rot, collecting and burning these fruit bodies helps to check further spread of *F. badius* in khair forests/plantations (Bakshi 1957). The principle of eradication of pathogens is best utilized in cntrol of diseases in forest nurseres. This is done by treatment of nursery soils with chemicals.These chemicals include soil fumigants like formalin,chloropicrin etc., fungicides like mercury fungicides, captan, thiram, blitox, zineb, brassicol etc., and soil acidifying chemicals like sulphur, sulphuric acid, ammonium sulphate etc. Nursery soil can also be sterilized by physical agencies like steaming of nursery soil, flooding etc.

Damping off in pine nurseries was effectively controlled by treatment of nursery bed soil with formalin (using 300 c.c. of formalin in 1m x 1m x 15cm nursery bed soil) The disease was also controlled effectively by mixing nursery bed soil with 20-25 gms of blitox, captan, thirid, zineb and cuman in one square meter of soil raised 15 cm from ground level (Reddy and Misra 1970). Root-rot caused by *Fusarium avenaceum* in spruce and fir nurseries in Himachal Pradesh was successfully controlled by treatment of nursery bed soil with formalin, 8-10 days before sowing.

Use of theurapeutants for eradication of fungal infections in the trees has been successfully experimented upon in case of stem rusts of pines and other canker diseases. In India, stem cankers due to *Corticium salmonicolor*,leaf and twig blight due to *Cylindrocladium quinqueseptatum* have been successfully eradicated on eucalypts and poplars by spray of cankered regions with a mixture of 2 g of dithane M-45 and 1 g of bavistin in one litre of water. Spike disease of sandal is found to be amenable to control by treatment of diseased plants with tetracycline antibiotics (Raychaudhuri *et al.* 1972). The treatment, however, caused temporary remission of symptoms only. Infection of *Fusarium semitectum* in su-babul seeds were successfully eradicated by dipping the infected seed in 0.1 per cent solution of emisan (methoxy ethyl mercury chloride) for 15 minutes (Sujan Singh *et al.* 1983d).

Protection : Protection to trees from attack of fungal pathogens can be achieved by modification of silvicultural practices, by use of chemicals or biological agents or through gentic resistance. Protection of forest trees by modification of silvicultural and management practices is by far the best method and widely used in forestry. Most of diseases especially heart-rots, stem cankers and stem wilts establish in trees through injuries caused by various agencies. Protection of trees from such injuries controls most of these diseases. Protection of sal from injuries caused by frost, fire and suppression reduces the incidence of heart-rot in sal forest. Protection of forest trees from injuries caused during logging operations, injuries - through illicit lopping and breaking of branches, stem injuries during rolling of logs after felling, protects forest trees from heart-rot diseases. *Fomes senex*, causing heart-rot in toon trees in avenues, attacks tree through injuries made on stem for numbering purposes. Avenue trees should be protected from such injuries to check establishment of heart-rot in them. Protection of *Casuriana equisetifolia* from lopping injuries would protect the trees from the attack of stem wilt pathogen, *Trichosporium vesiculosum* (Bakshi 1951).

In root-rot diseases, isolation of diseased trees by 1.5m long, o.7m deep,0.3m wide trenches dug out across the lines protects the adjoining healthy trees from infection by root-rot pathogen (Bakshi *et al.*1976). Selection of low side shoots originating at or below ground level for future crop in coppice teak forests helps in raising teak free from heart-rot (Sujan Singh *et al.* 1973).

Protection of trees from attack by pathogenic fungi is secured byuse of fungicides which form a thin layer on plant surfaces and do not permit the germination of fungal spores. This protection is best practised in nurseries where diseases attacking aerial parts of seedling are sprayed with fungicides to protect these seedlings from various diseases. Spray of pine seediings with 0.6 per cent dithane M-45 or cuman-L protects them from Cercoseptoria needle blight (Sujan Singh *et al.* 1983). Sissoo seedlings were completely protected from attack of a rust disease, *Maravalia achroa* in New Forest (Dehra Dun) nurseries and plantationss by spray of plants with 0.2 per cent dithane M-45. Eucalyptus seedlings in social forestry nurseries were proected to a great extent by spray of blitox-50 at 0.3% concentration from collar rot disease.

Protection of trees from diseases by biological agents is gaining importance now-a-days due to dangers of pollution inherent in use of chemical. The best example of biological protection of trees is by inoculation of stumps of coniferous trees with an innocuous fungus, *Peniophora gigantea* to protect these stumps from attack of *Heterobasidion annosum* which usually colonizes freshly exposed stumps of conifers and spreads subsequently in the forest by root contact to adjoining healthy trees.

Genetical protection to trees can be given by breeding trees resistant to their dangerous disease. There are two basic techniques which operate in evolving resistant tree species. The first is selection and the second breeding for resistant varieties. For control of pink disease in high rainfall area of Kerala State, a large number of tree species were screened in field plantings and among them, *Eucalyptus torelliana* and *E. deglupta* among eucalypts and *Terminalia myriocarpa*, *Vateria indica*, *Bischofia javanica*, *Albizia falcataria*, *A. moluccana* and *Pterocymbium tinctorium* among indigenous hardwoods were found resistant to pink disease. Work on breeding trees resistant to diseases has not been done in India to a great extent though *Pinus wallichiana*, an indigenous pine, has been successfully hybridized with *Pinus* an indigenous pine, has been successfully hybridized with *Pinus strobus* in U.S.A. to produce a hybrid which was resistant to *Cronartium ribicola*, a serious stem blister rust disease of white pines (Heimburger 1972).

SUMMARY

The paper highlights disease problems of Indian forests and control strategies which have generally been adopted in the country. Diseases in forest and social forestry nurseries may be caused by soil-inhabiting pathogens/ occurring in nearby plantations or natural forests/pathogens inadvertently introduced from other regions of the country or from foreign countries on planting material.

In natural forests, heart-rot diseases caused greatest losses inmerchantable timber. Root-rots generally remain in endemic from unless there is some deviation in prescribed management practices.

Plantations raised on forest sites suffer most from root-rot pathogens. Sissoo and *Casuarina* suffer from wilt diseases; former when raised on unsuitable site and the latter when subjected to illicit lopping and injudicious pruning. Poplars subjected to tractor blade injuries in agro-forestry plantations suffer from hear-rots. Exotic trees in plantations suffer from indigenous pathogens as well as from pathogens in advertently introduced into the country. The latter may sometimes cause heavy damage to susceptible indigenous tree species. Most of the serious diseases occurring in forest areas have been recorded in social forestry plantations which in addition may also suffer from diseases present on agriculture crops.

In forestry crops, approach towards integrated control measures based on the principles of exclusion, avoidance, eradication and protection is most appropriate. A pethogen may be excluded from a forest area through

effective quarantine practices. The principle of avoidance can be practised by refraining from planting of tree species where their pathogens are expected to develop in epidemic form. Eradication of a disease from a particular area can be effected by destruction of infected trees or tree parts/fungal fruit bodies/alternate hosts of rust pathogens. Protection to trees against diseases can be afforded through amendment of silvicultural practices, by giving prophyllactic spray of fungicides, through use of innocuous fungi as protectants and through genetic resistance.

भारत में वन व्याधिकी; इसकी समस्याएं तथा रोग नियन्त्रण की समरनीतियां

सुजान सिंह

सारांश

प्रस्तुत अभिपत्र में भारत के वनों में होने वाले रोगों तथा उनका नियन्त्रण करने के लिए देश में सामान्यत अपनाई गई समरनीतियों पर प्रकाश डाला गया है। वन तथा सामाजिक वानिकी के लिए बनाई गई रोपणियों में रोग मृदा-निवासी रोगजनक, पास में लगे प्राकृतिक वनों या रोपवनों में लगे रोगजनक देश के अन्य क्षेत्रों या विदेशों से लाए रोपण पदार्थों के साथ असावधानी से आगए रोगजनको से हो जाते हैं।

प्राकृतिक वनों में सार-अपक्षयण रोगों से विक्रेय प्रकाष्ठ को सबसे ज्यादा नुकसान पहुंचता है। जड़ अपक्षयण प्रायः सीमित परिमाण में उस समय तक बना रहता है जब तक निर्धारित वन प्रवन्ध प्रक्रियाओं में कोई परिवर्तन नहीं किया जाता।

वन स्थलियों में लगाए गए रोपवनों को सबसे अधिक नुकसान जड़-अपक्षयी रोगजनकों से पहुँचता है। शीशम और कैजुअरिना को मुरझाने का रोग लगता है, पहली वृक्ष जाति को उस समय जब उसे अनुपयुक्त स्थलों पर लगाया जाता है तथा दूसरी वृक्षजाति को उस समय जब उसका अवैध झंगान या बुद्धिहीन ढंग से कर्तन किया जाता है। कृषि-वानिकी रोपवनों में लगाए पोपलरों (वनपिपलों) की ट्रैक्टर (कार्षित्र) फलक से क्षति हों जाए तो उनमें सार-अपक्षयण होने लगता है। रोपवनों में लगाई विदेशी वृक्ष जातियों को देशी तथा देश में असावधानी से चले आए रोगजनकों से भी हानि पहुँचती है। बाहर से आए रोगजनक कभी-कभी रोगप्रवण देशी वृक्ष जातियों को भारी हानि पहुँचा देते हैं। वनों में होने वाले अधिकांश गंभीर रोग सामाजिक वानिकी के रोवनों में भी होते अभिलिखित किए गए हैं जिन्हें उन रोगों से भी हानि पहुँचती पाई गई है जो कृषि फसलों में होते हैं।

वन सस्यों में एककृत नियन्त्रण उपाय अपनाना सबसे अधिक उपयुक्त रहेगा, जिसे प्रथकरण, बचाव, निर्मूलन और सुरक्षा के सिद्धान्तों पर आधारित करना चाहिए। रोगजनक को प्रभावी निरोधात्मक उपायों द्वारा किसी वन क्षेत्र से पृथक कर लिया जाय। बचाव का सिद्धान्त इस प्रकार व्यवहार में लाया जाता है कि ऐसी वृक्ष जातियों को न लगाया जाए कि जिनके रोगजनकों कि व्यापक परिणाम में विकसित होने की वहां आशंका हो। किसी क्षेत्र से किसी रोग को निर्मल करने का सिद्धान्त इस तरह उपयोग में लाया जाता है कि रोगग्रस्त वृक्ष या वृक्ष भागों/कवकी फलकायों/गेरिक रोगजनों के एकान्तर पोषियों को नष्ट कर दिया जाता है। रोगों के प्रति वृक्षों की सुरक्षा वनसम्वर्धन प्रक्रियाओं में संशोधन करके, कवकनाशी पदार्थों का निरोधात्मक छिड़काव करके; अहानिकर कवकों को सुरक्षा प्रदाताओं की तरह उपयोग करके और जननिक विरोधशक्ति बढ़ाकर व्यवहार में लाया जा सकता है।

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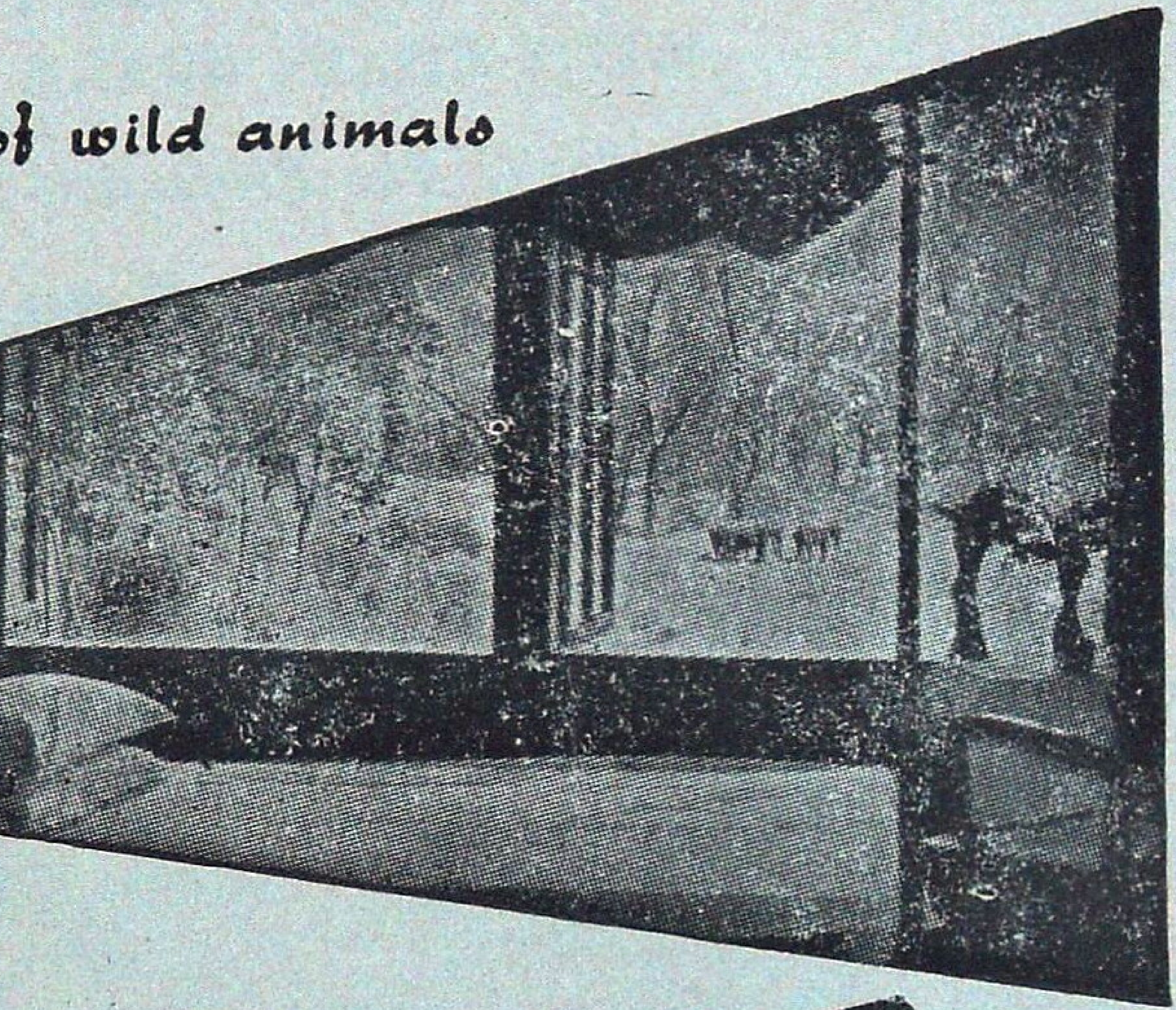

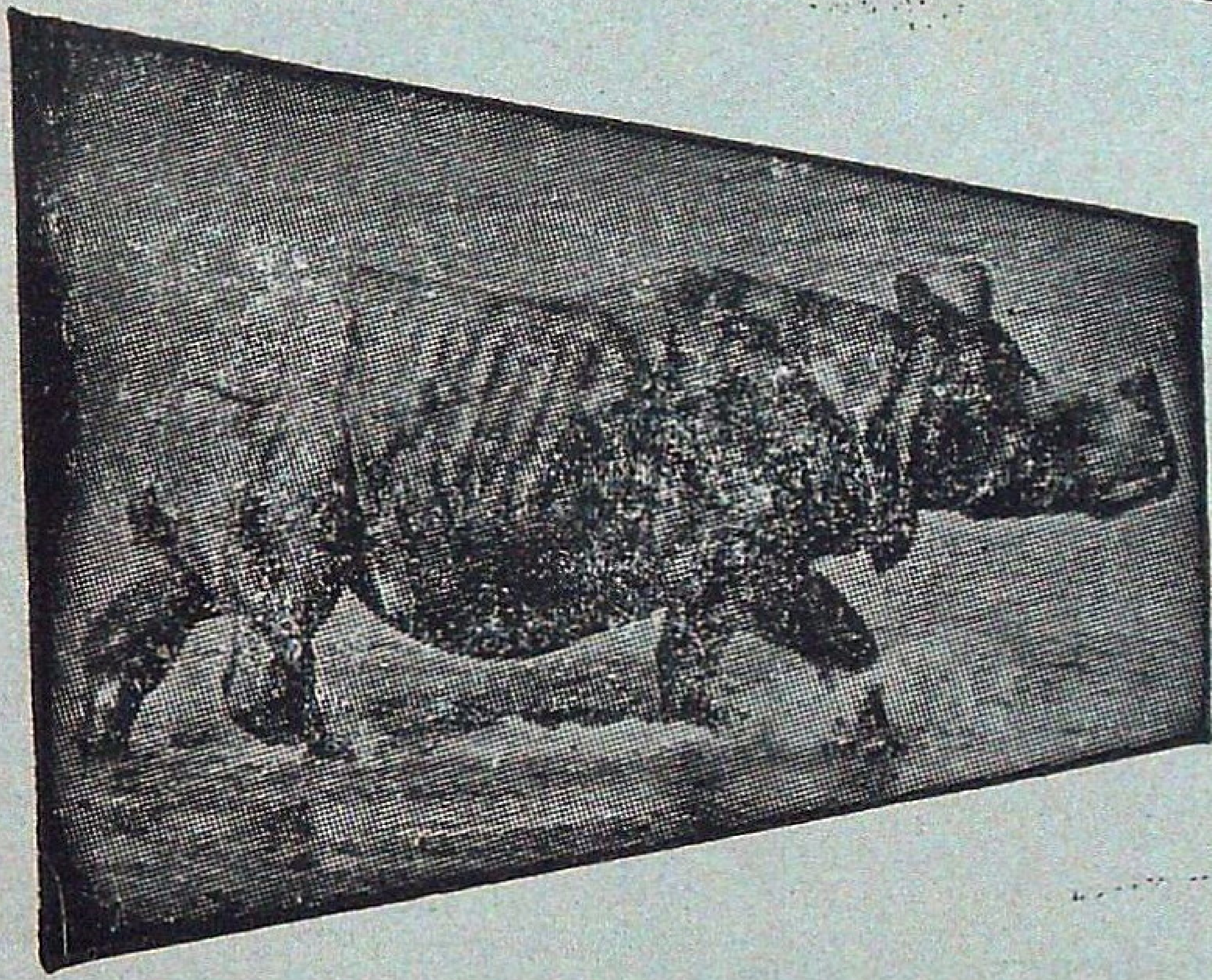

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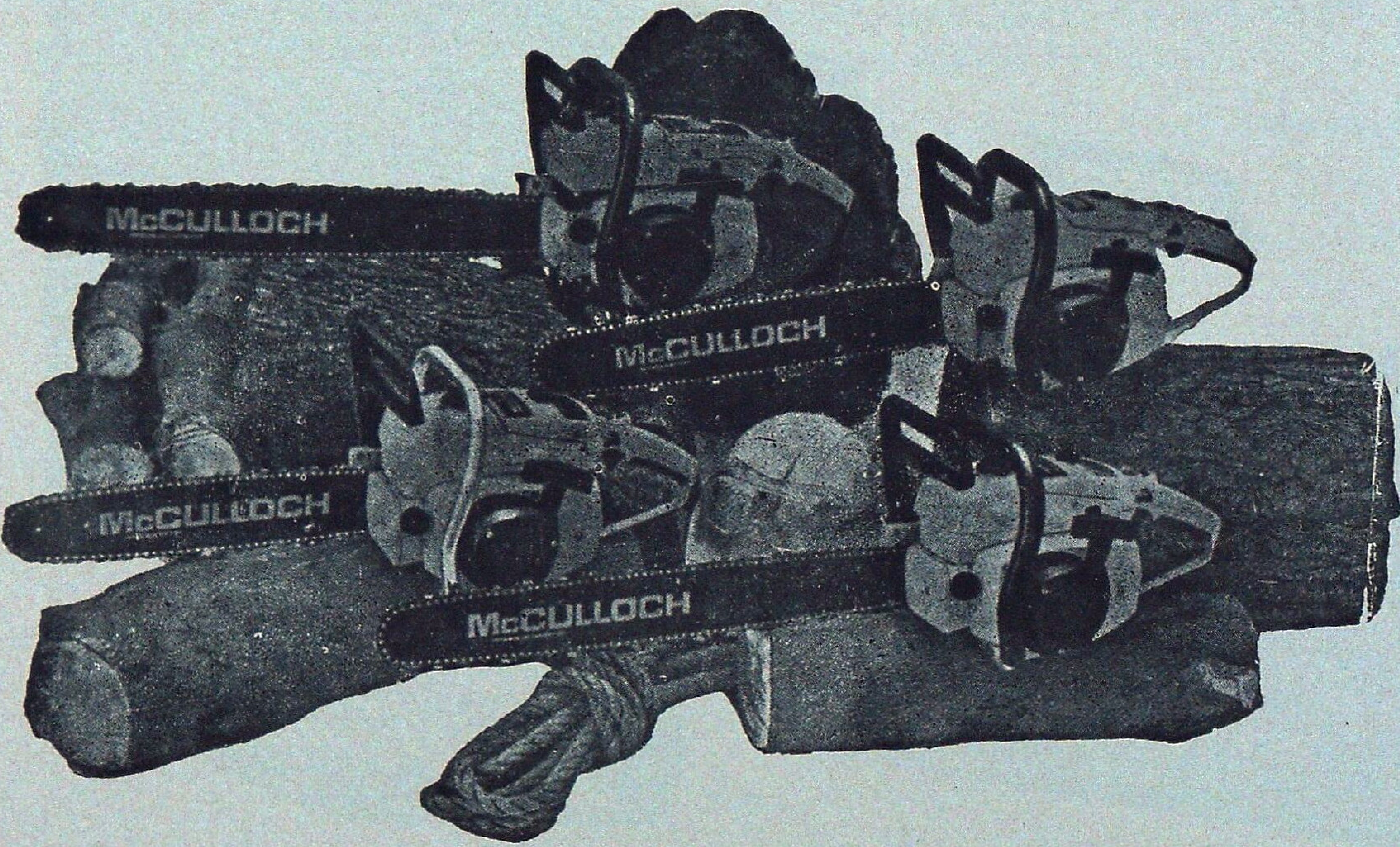

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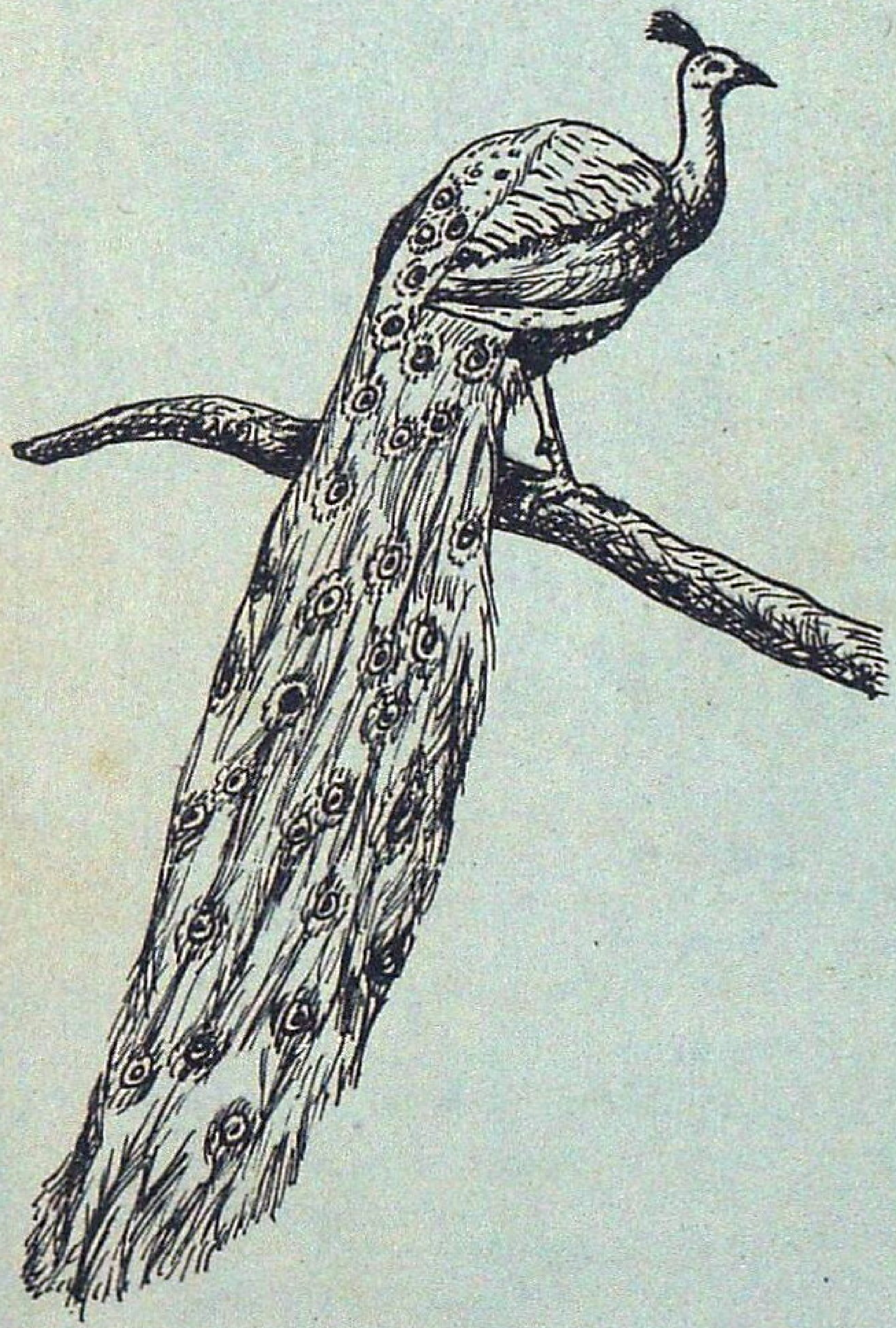

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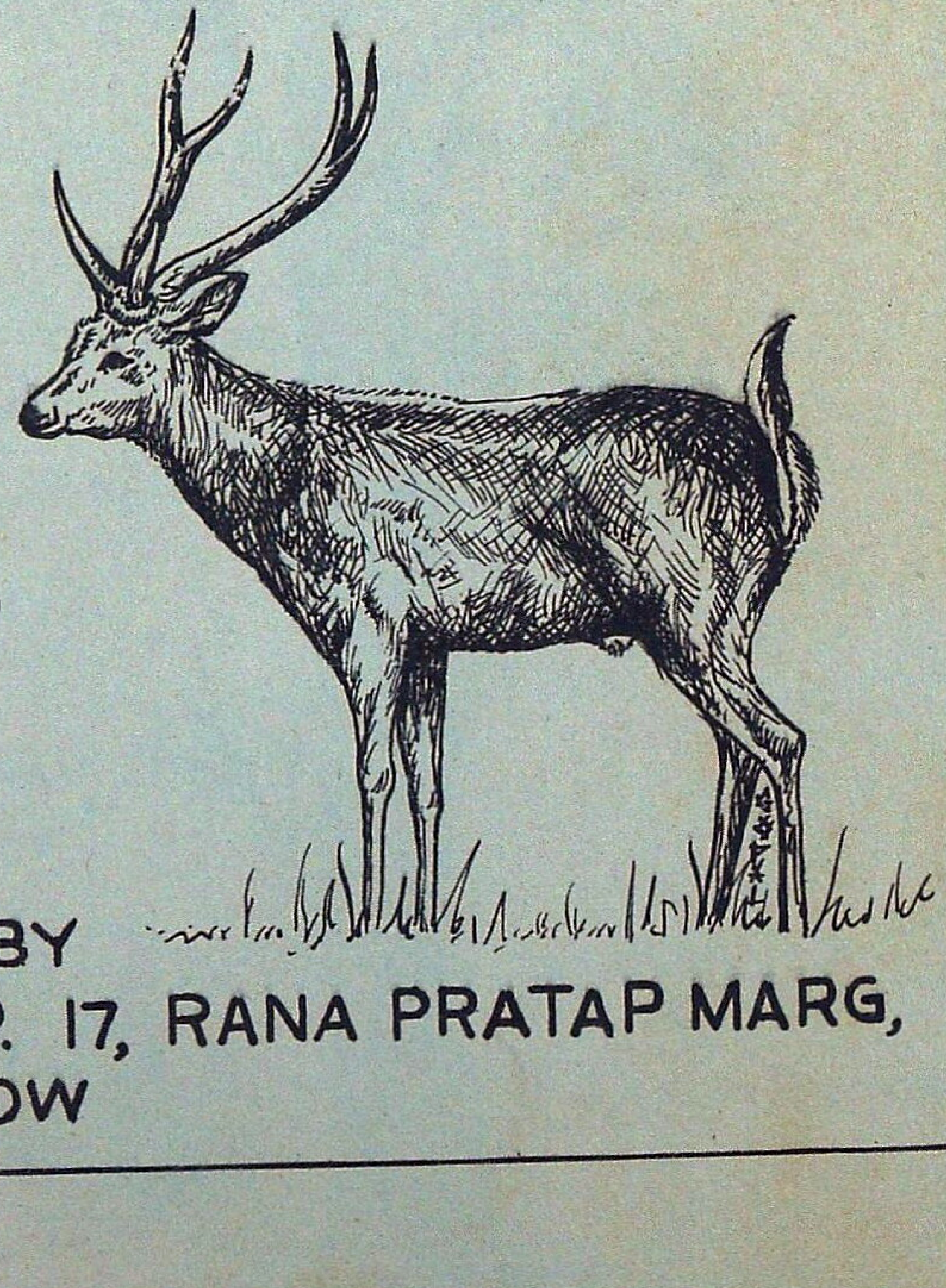

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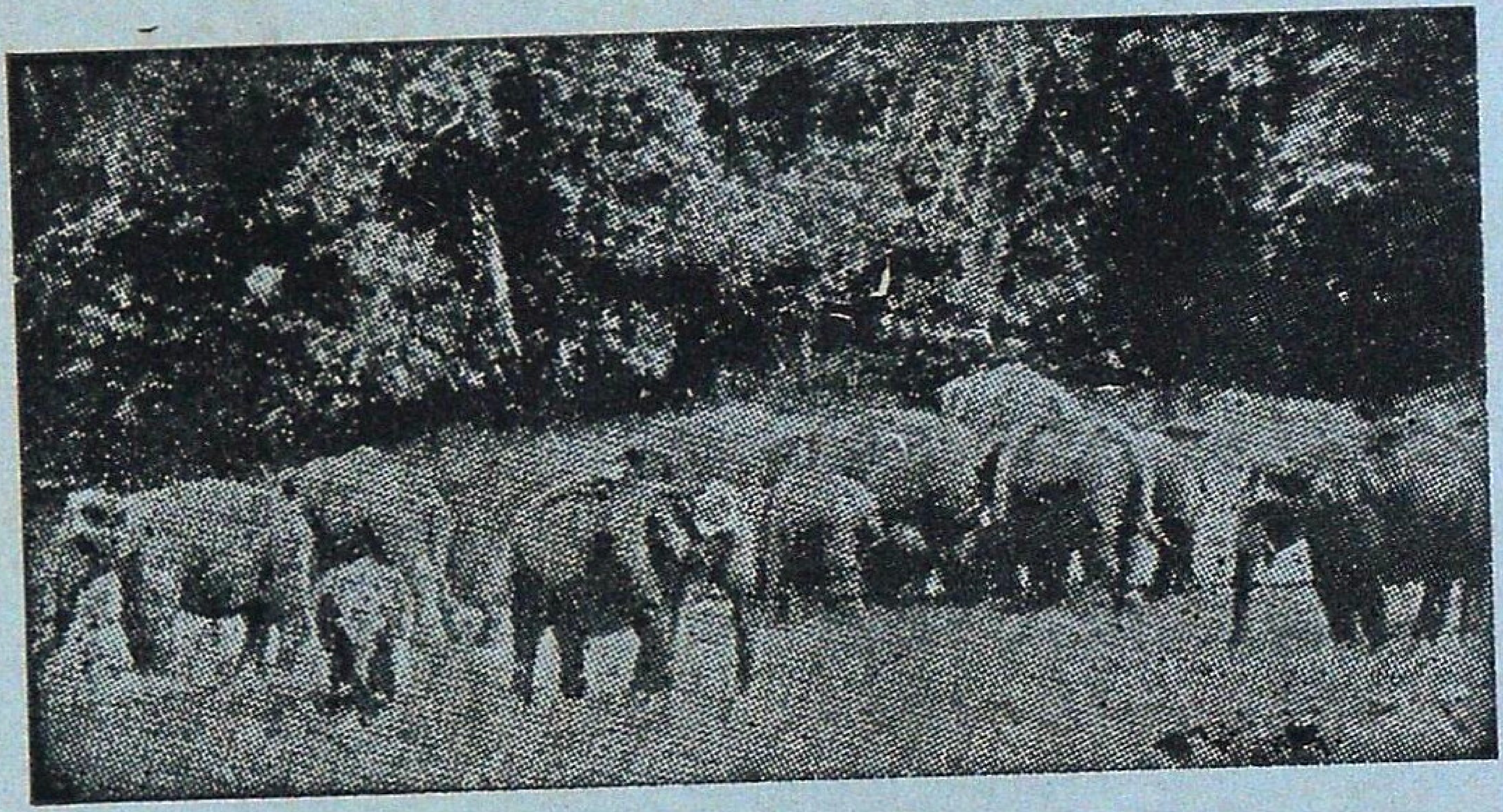

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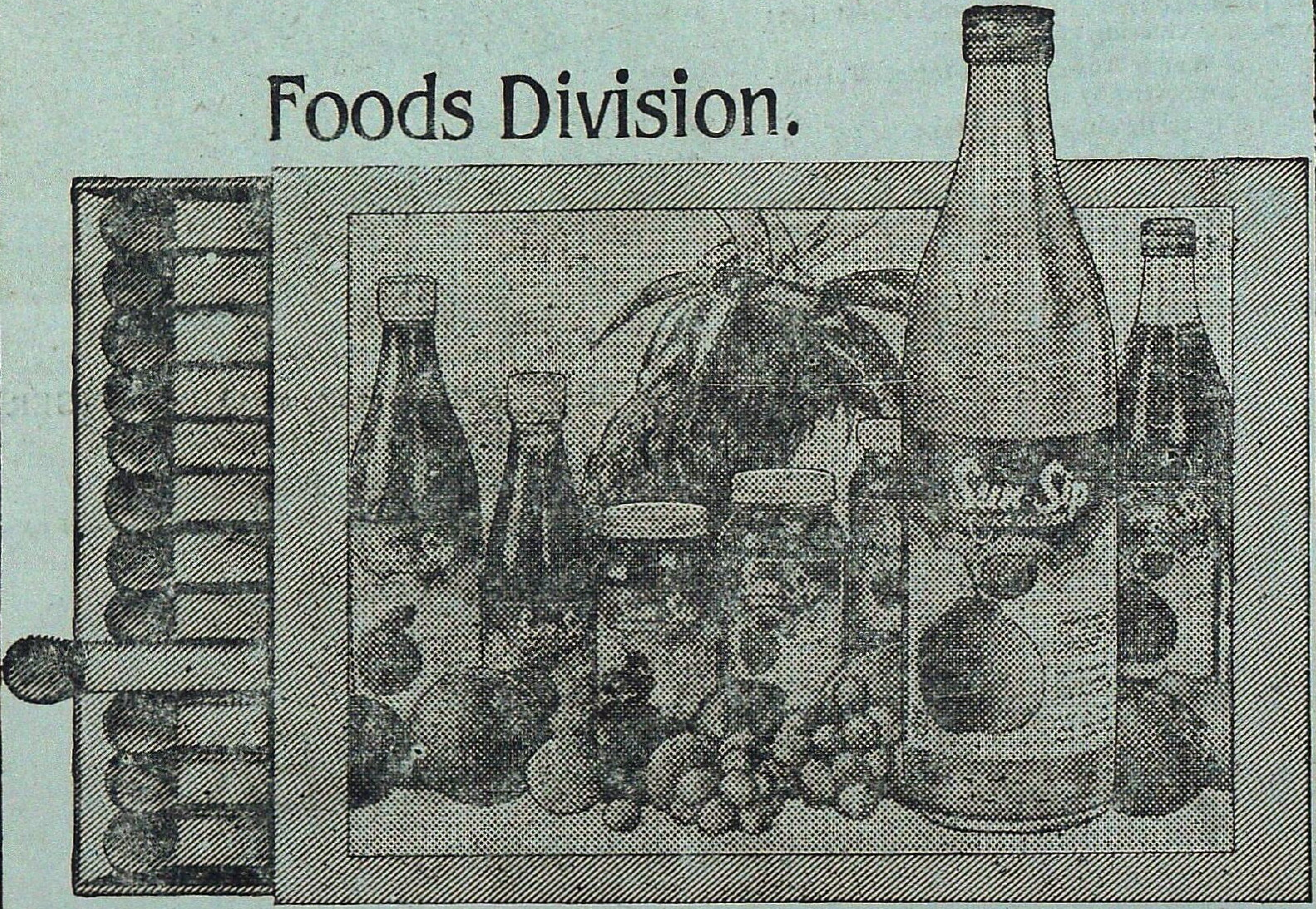

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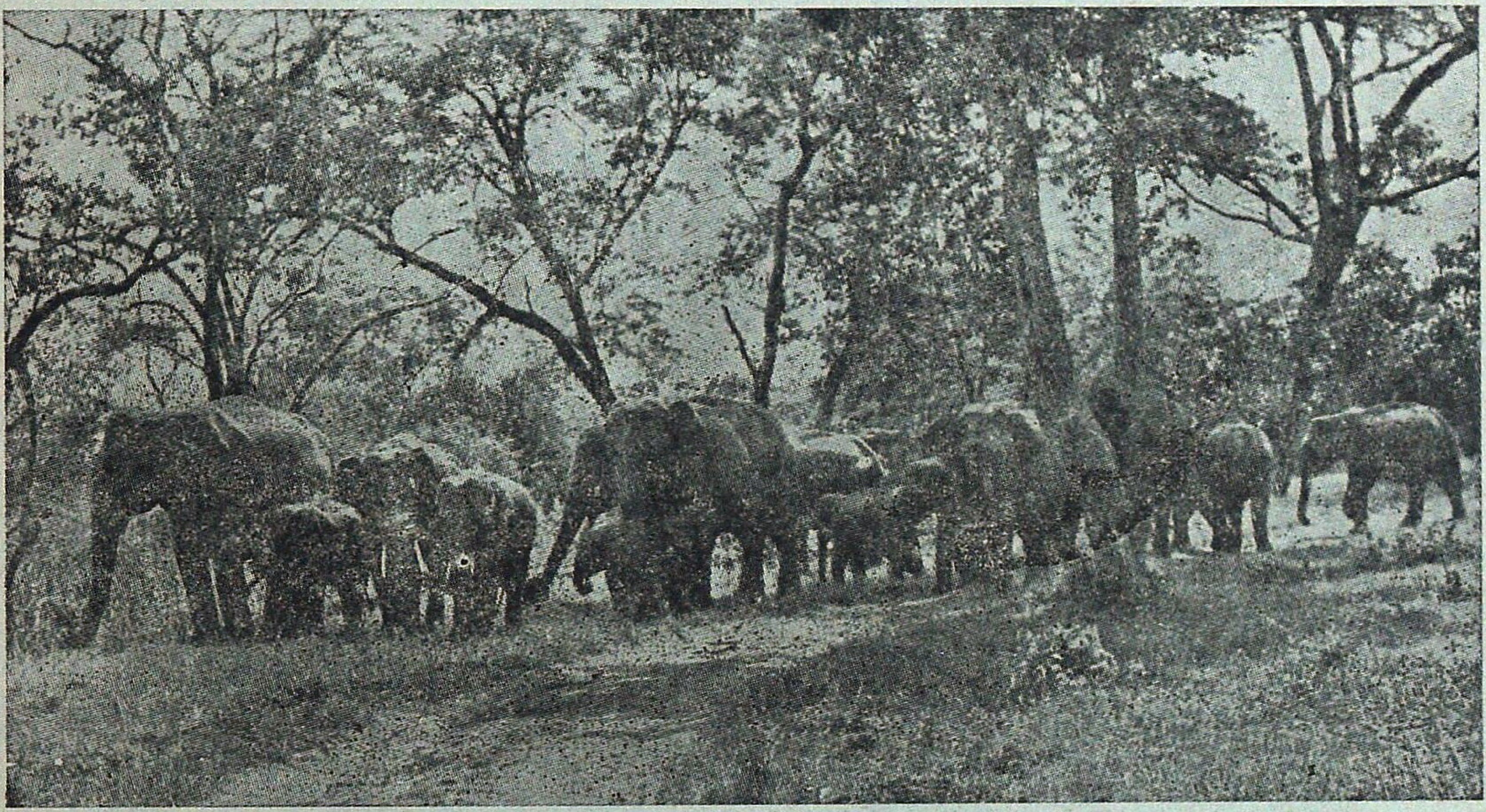

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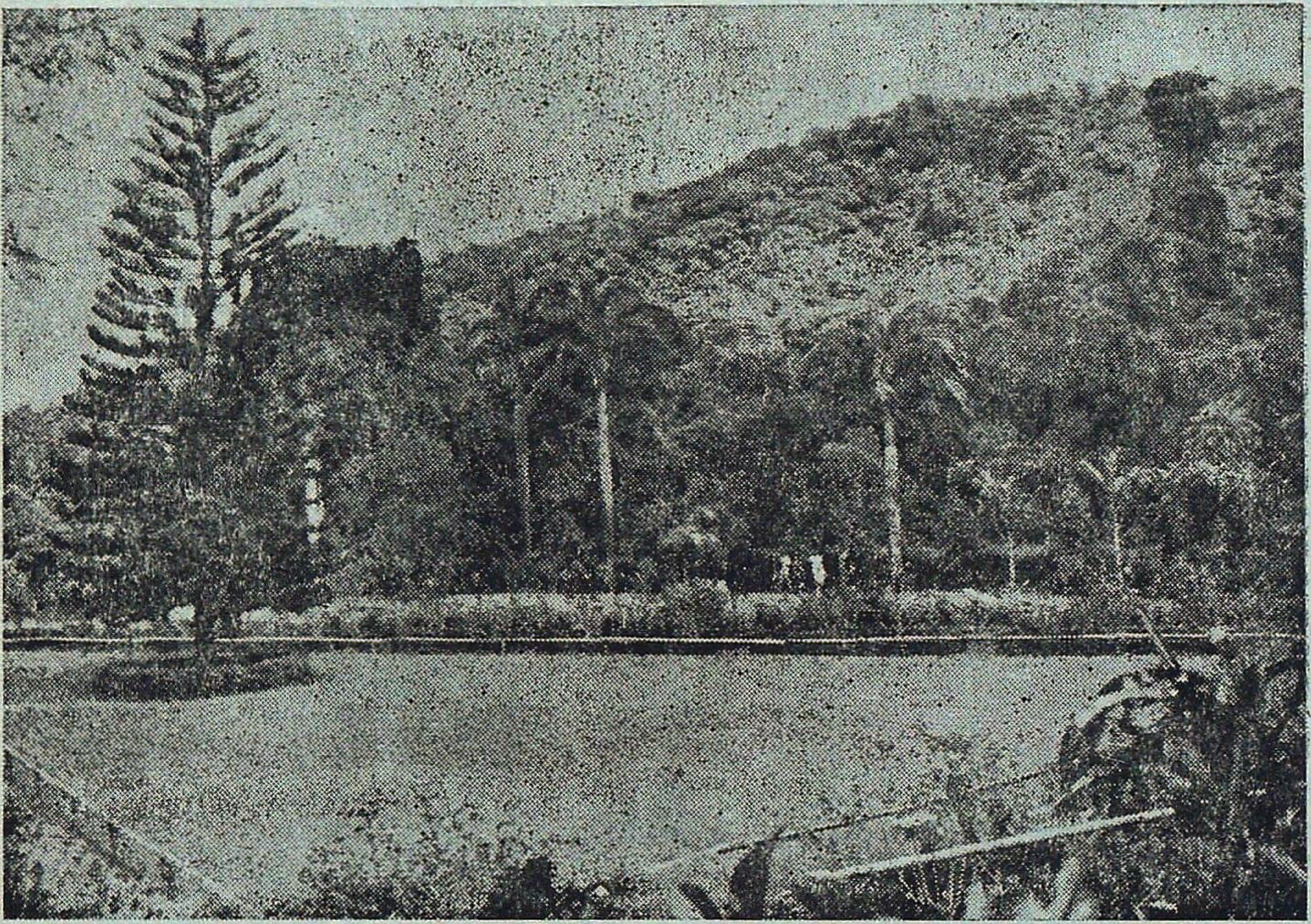

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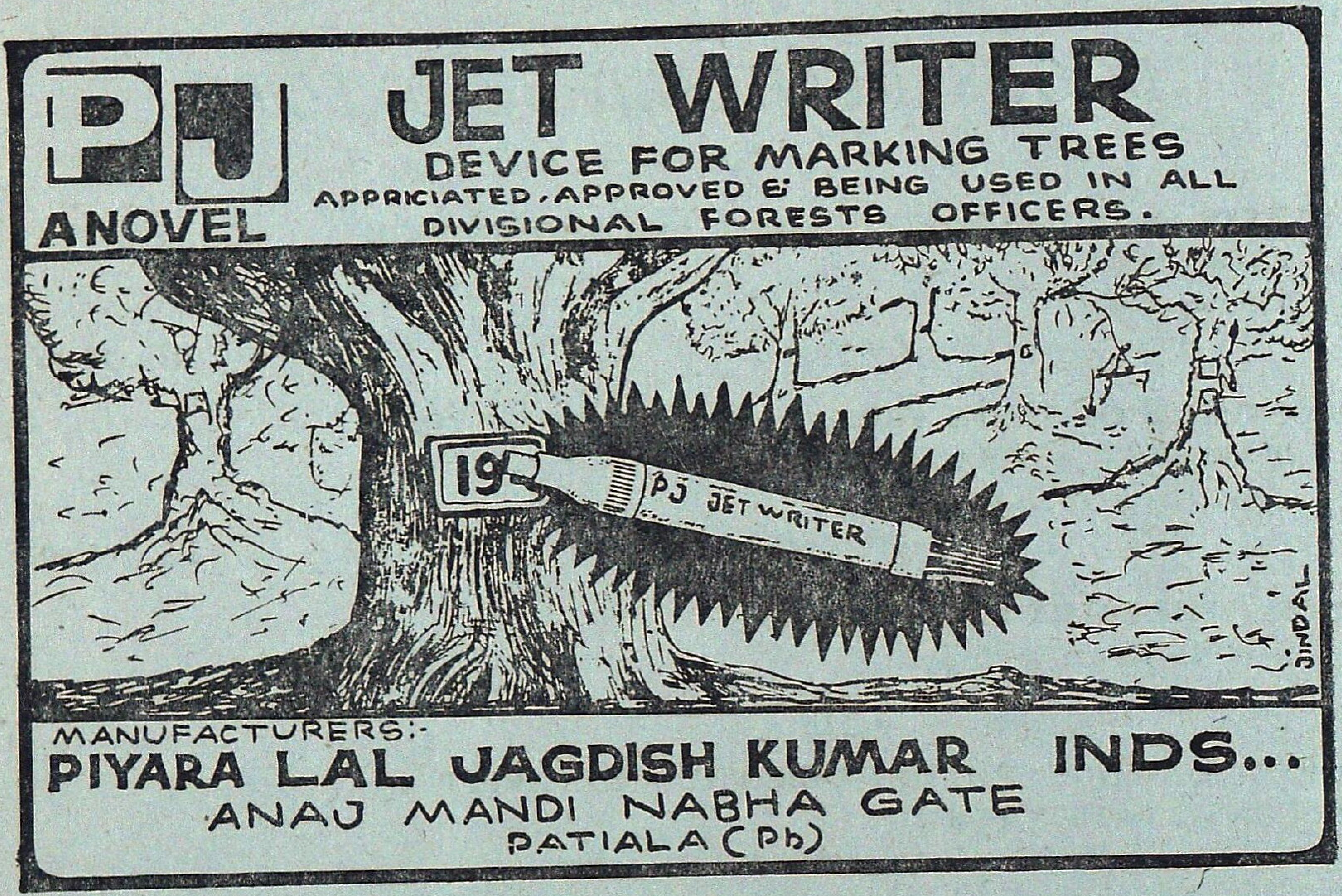

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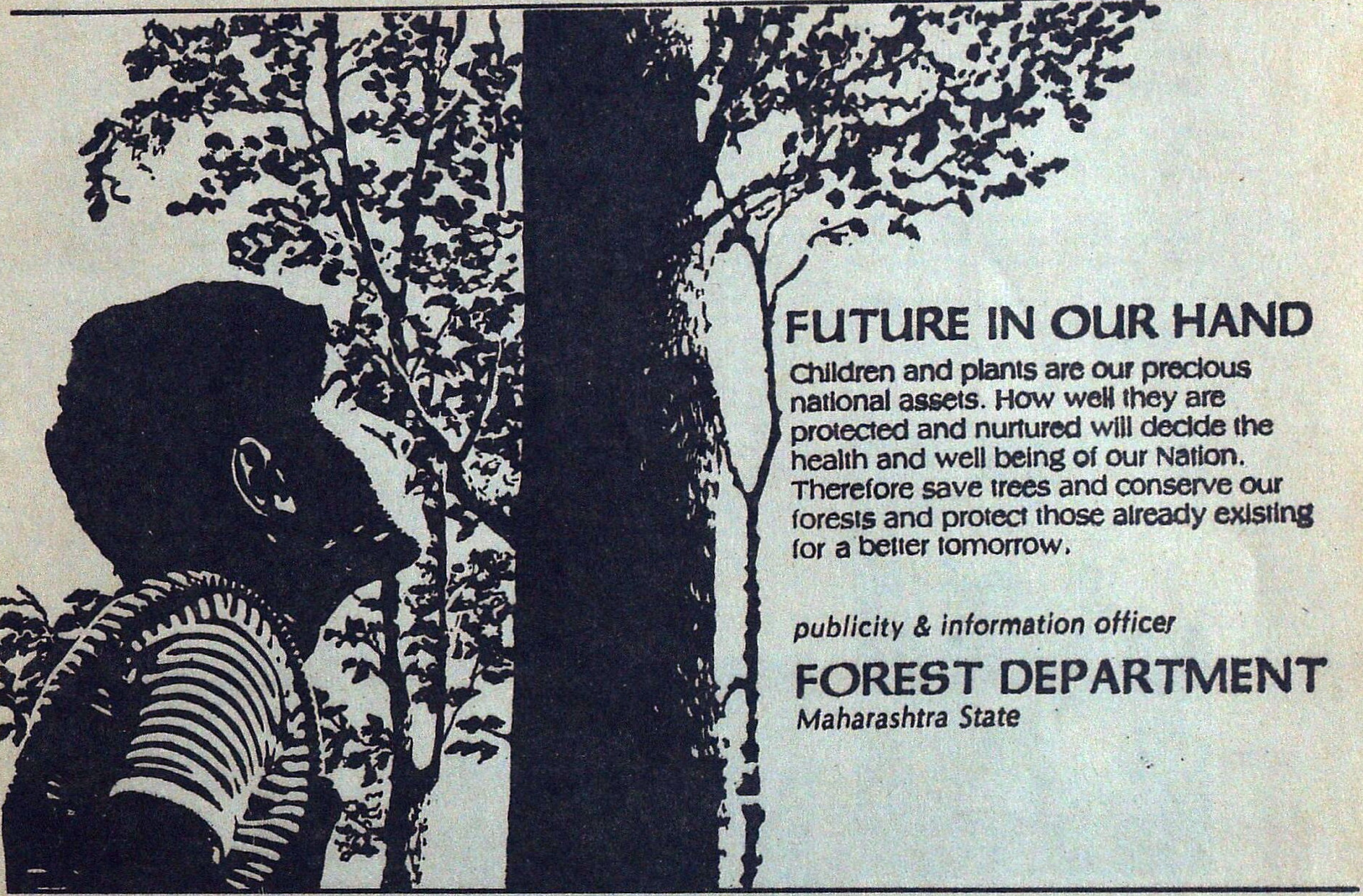

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FOREST DEPARTMENT

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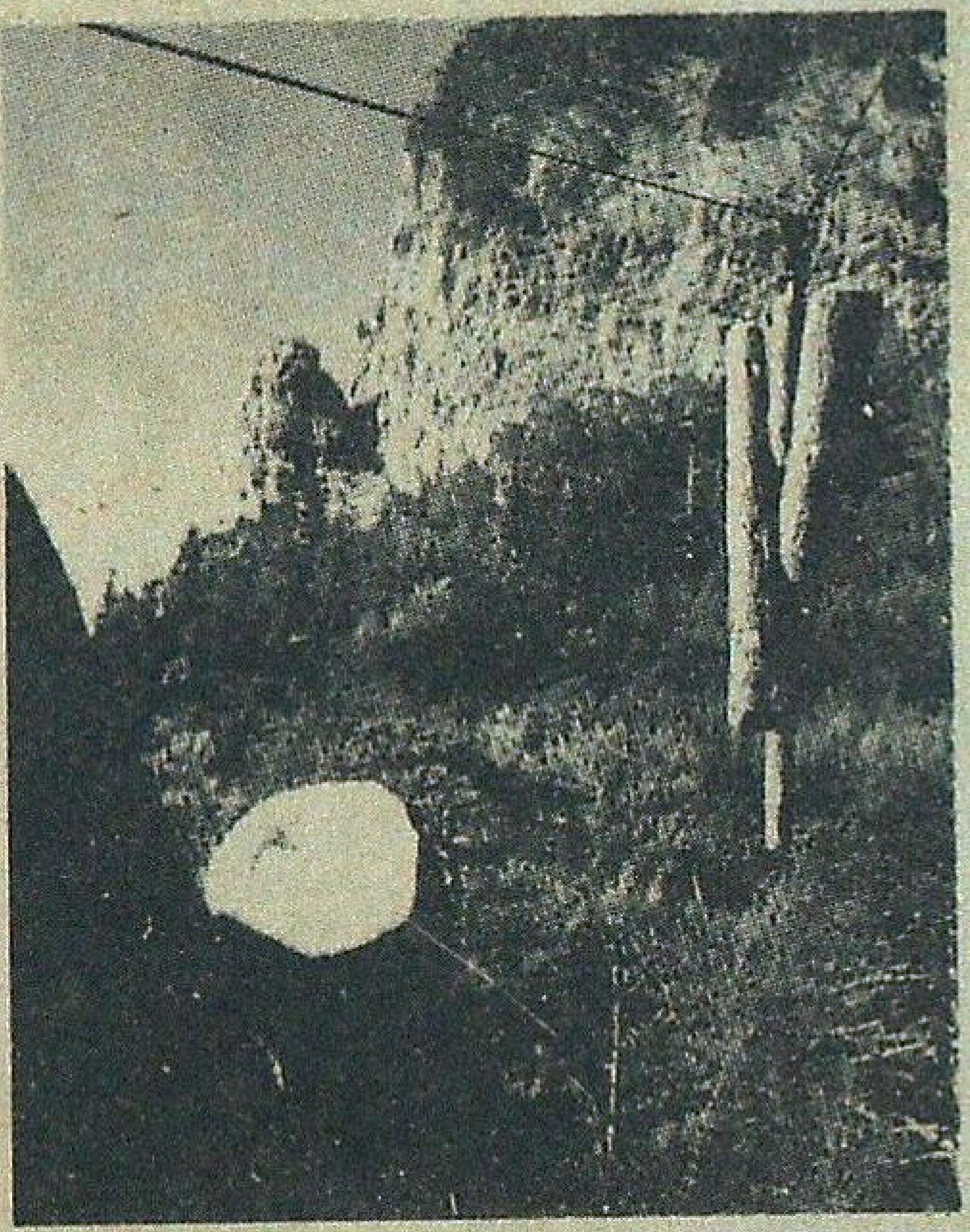
TO LET

During my life's Work I have been saved and healed through the power of God

Until 1960, I was an ungodly man and knew for sure that I would go to hell when I died. At the funeral of my friends and relatives I always thought about this. Although I respected the true believers, I did not know how to receive such wonderful peace, until God led me into prayer.

From time to time, a vehicle from the X-ray Institute would visit our village of Reichenbach. It was also requested to visit our factory where we manufacture Skyline Cranes.



Our staff, my wife, our children and myself had X-ray examinations. After a few days the Institute called me to say that they had found a spot on my lung, and that I must go to visit a doctor for further examination and possible treatment.

A few years earlier, my younger brother, who also served our customers (see pictures) had died of lung cancer, and I was a smoker as he had been. This left me with a fear of having the same illness. I was convinced that doctors could not heal lung cancer, and that only the power of God could bring healing.

I only prayed to God when I had problems in my own life, my family or business and could not help myself or find help from others. The Lord always answered my prayers and helped me every time, even when I did not have peace with God I trusted in his promises: "Call upon me in the day of trouble; I will deliver you, and you will honor me" (Psalm 50:15). With regard to the spot on my lung, for a whole week I prayed about twenty times a day, begging our Lord to heal me. During my prayer God asked me to promise to serve him, and this I did, without the condition of him healing me.

On the advice of the X-ray Institute I went to a doctor, who arranged for further X-ray examinations. As we examined the original X-ray together by a window, the spot was clearly to be seen, but on examination of the subsequent films my lungs were shown to be without the spot. My prayers had been answered and God had healed me! I continued my prayers, in which I thanked him for the healing, and the more I prayed the more I felt his presence. The Bible says: "Come near to God and he will come near to you" (James 4:8). This happened through my earnest prayers.

The next Sunday, as I was humbly in prayer outside my home, longing for the presence of God, his power came down from heaven like a cloud that almost pressed me down to the ground. Contained in the cloud was a brilliant light which almost blinded me and restricted my vision to two or three meters. In the twinkling of an eye, something wonderful came into my heart.

In a vision God showed me the name of "Jesus" written in great golden letters. After this marvelous experience I knew without a doubt that Jesus had come into my heart.

When for the first time Jesus spoke to me, he said: "Now thank God for what you have received", and as I walked from my home to Scharnachtal I thanked God for Jesus and the wonderful experience he had given me. It was as if a great burden had been lifted off me, and I did not know that I was carrying such a heavy load of sin.

Before returning home, I asked God to protect me from all evil, and that the devil could never rob me of this great experience. Later, Satan tried, but he could not succeed because I had the protection of the blood of our Lord. On the cross of Calvary Jesus shed his blood and died and there defeated Satan. This I know and believe fervently.

Since this extraordinary event, my heart is at peace and overflowing with joy and with the assurance that our Lord will never forsake me. When I die I will be with him and the Kingdom of Heaven will be my reward. The way to eternal life is to have Jesus in our heart. The Bible states: "God has given us eternal life, and this life is in his Son. He who has the Son has life; he who does not have the Son of God does not have life" (1 John 5:11, 12).

I confessed my sins which the Holy Spirit revealed to me and made everything right. I was shown that our Lord had forgiven all the wrongdoings of my past life. On this earth we are born of our mothers, but to enter heaven we must be born of the Spirit of God. The experience of rebirth is like a change of government in the heart, and when Jesus comes into our hearts, the spirit of the world must leave.

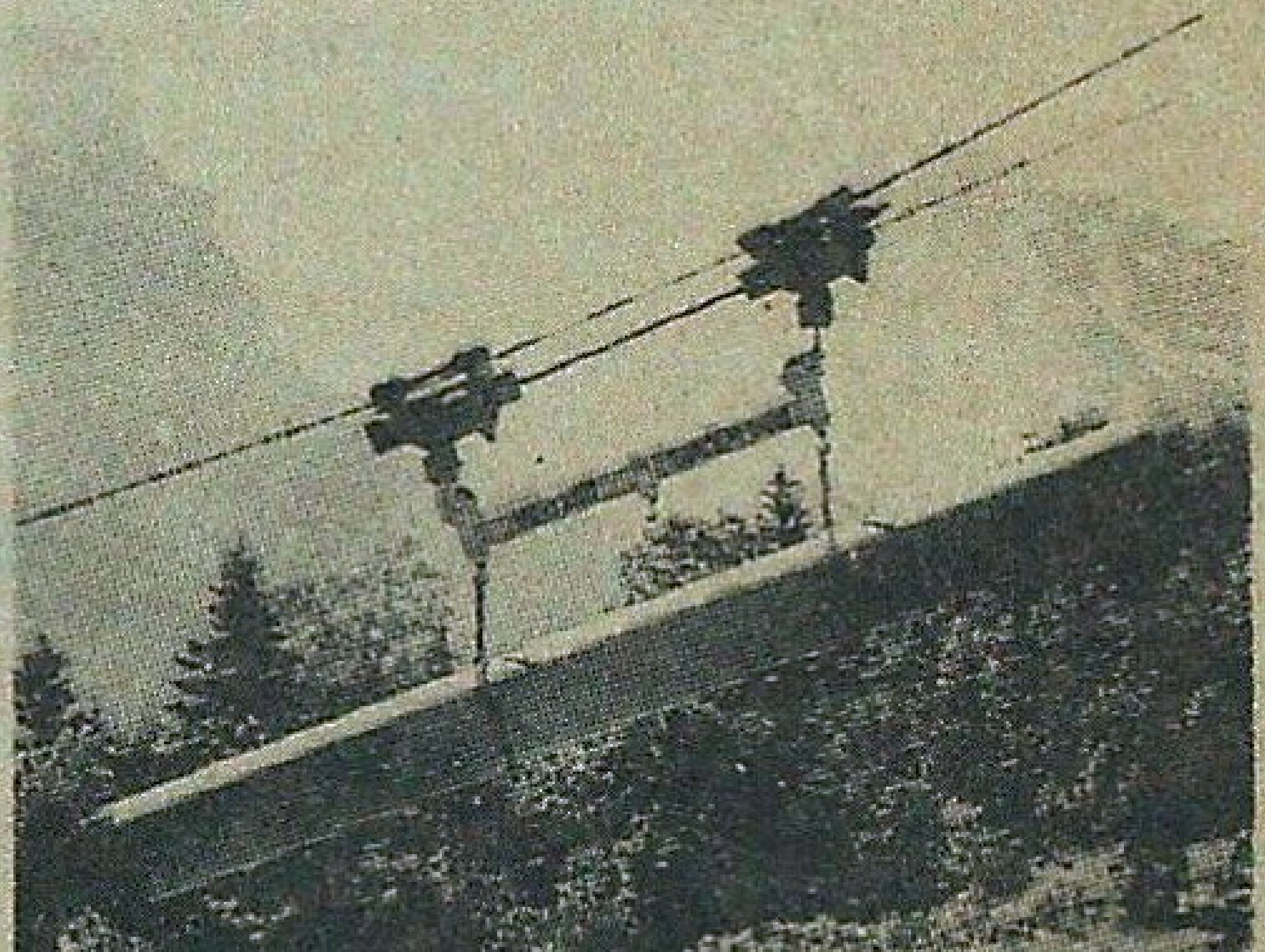
Because Adam and Eve had fallen into sin we do not, by nature, have Jesus in our hearts, and all men have inherited their sinful ways from them. Therefore, we commit sins which, as we know, separate us from God, and as mere mortals we are powerless to free ourselves from sin. For this reason God, through his great love, sacrificed his beloved Son Jesus Christ to save us from sin. Only Jesus has God's authority to forgive the sins of mankind, for he said: "I am the way and the truth and the life. No one comes to the Father except through me" (John 14:6). Peter says of Jesus: "There is no other name under heaven given to men by which we must be saved" (Acts 4:12).

He who wishes to be saved must seek God with all his heart. "You will seek me and find me when you seek me with all your heart", says the Lord (Jeremiah 29:13). Through earnest prayer and longing for God, his Son Jesus will enter into our hearts and he will save us from the eternal damnation of hell, and give us the peace of God and eternal life.

And so, with joy I say, seek our Lord with fervent prayer, then you will find and be filled with the peace and the joy he has filled me. It is my prayer for the whole of mankind to enjoy such blessings and find salvation. May God bless you!

It does not matter what our work is, God wants everybody to be saved.

Jakob Wyssen



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For detailed instructions see the editorial in the *Indian Forester* of May 1950.

THE
INDIAN FORESTER

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